Cidra Groundwater Contamination Superfund Site

Cidra, Puerto Rico
November 2013

EPA Region 2

EPA ANNOUNCES PROPOSED CLEANUP PLAN

This Proposed Plan describes the remedial alternatives developed for the Cidra Groundwater Contamination Superfund Site (the Site) in Cidra, Puerto Rico, and identifies the preferred remedy for the Site with the rationale for this preference. This document was developed by the U.S. Environmental Protection Agency (EPA), the lead agency for Site activities, in consultation with the Puerto Rico Environmental Quality Board (PREQB), the support agency. EPA is issuing this Proposed Plan as part of its public participation responsibilities under Section 117(a) of the Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C. § 9617(a) (CERCLA, commonly known as Superfund) and Sections 300.430(f) and 300.435(c) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

The nature and extent of the contamination at the Site and the remedial alternatives summarized in this document are described in detail in the Remedial Investigation (RI) and Feasibility Study (FS) reports.

EPA's preferred remedy for the Site consists of the following FS alternatives to address soil and groundwater contamination at the Site:

- Alternative IDC-S3 - *Soil Vapor Extraction and Containment* at property formerly operated by International Dry Cleaners (IDC).
- Alternative R-S3 - *Soil Vapor Extraction with Thermal Treatment; Excavation, Disposal, and Backfill; and Containment* at

MARK YOUR CALENDAR

PUBLIC MEETING
December 4, 2013 at 6:00 pm
Cidra City Hall

PUBLIC COMMENT PERIOD
November 20, 2013-December 20, 2013

INFORMATION REPOSITORY
The administrative record file, which contains copies of the Proposed Plan and supporting documentation, is available at the following locations:
Cidra Municipal Library
Hours: Monday – Friday 9:00 am to 3:00 pm

U.S. Environmental Protection Agency
City View Plaza II- Suite 7000
#48 PR-165 Km. 1.2
Guaynabo, PR 00968-8069
(787) 977-5865
Hours: Monday – Friday 9:00 am to 5:00 pm
By appointment.

Puerto Rico Environmental Quality Board
Emergency Response and Superfund Program
Edificio de Agencias Ambientales Cruz A. Matos
Urbanización San José Industrial Park
1375 Avenida Ponce de León
San Juan, PR 00926-2604
(787) 767-8181 ext 3207
Hours: Monday – Friday 9:00 am to 3:00 pm
By appointment.

U.S. EPA Records Center, Region 2
290 Broadway, 18th Floor
New York, New York 10007-1866
(212) 637-4308
Hours: Monday-Friday – 9:00 am to 5:00 pm
By appointment.

property formerly operated by Ramallo Brothers Printing, Inc. (Ramallo).

- Alternative GW-4 - – *In-Situ Treatment and Long-term Monitoring* for groundwater contamination under and downgradient of Ramallo. This alternative could be enhanced, as necessary, with extraction and treatment.

These remedies also include institutional controls that would restrict the future use of the soil at the IDC and Ramallo properties located within the Cidra Site and groundwater under and downgradient of Ramallo. IDC formerly operated a dry cleaner located in the northern portion of the Site. Ramallo is a vacant facility located within the Cidra Industrial Park.

The remedies described in this Proposed Plan are the preferred remedies for the Site. EPA, in consultation with PREQB, will select the final remedy for the Site after reviewing and considering all comments submitted during a 30-day public comment period. Changes to the preferred remedy, or a change from the preferred remedy to another remedy, may be made if public comments or additional data indicate that such a change will result in a more appropriate remedial action. EPA is soliciting public comment on all of the alternatives considered for the Site because EPA may select a remedy other than the preferred remedy.

COMMUNITY ROLE IN SELECTION PROCESS

EPA relies on public input to ensure that the concerns of the community are considered in selecting an effective remedy for each Superfund site. To this end, this Proposed Plan has been made available to the public for a 30-day public comment period which begins with the issuance of this Proposed Plan and concludes on December 20, 2013.

EPA is providing information regarding the investigation and cleanup of the Site to the public through a public meeting and the public repositories, which contain the administrative record file. EPA encourages the public to gain a more comprehensive understanding of the Site and the Superfund activities that have been conducted there.

The public meeting held during the comment period is to provide information regarding the Site investigations, the alternatives considered and the preferred remedy, as well as to receive public comments. Comments received at the public meeting, as well as written comments, will be documented in the Responsiveness Summary Section of the Record of Decision (ROD), the document that formalizes the selection of the remedy.

Written comments on this Proposed Plan should be addressed to:

Adalberto Bosque, PhD, MBA
Remedial Project Manager
U.S. Environmental Protection Agency
City View Plaza II - Suite 7000
48 RD, 165 Km. 1.2
Guaynabo, PR 00968-8069
Telephone: (787) 977-5825
Fax: (787) 289-7104
E-mail: bosque.adalberto@epa.gov

SCOPE AND ROLE OF ACTION

EPA is addressing the cleanup of this Site by implementing a single, comprehensive remedial action to address the soil, soil vapor, and groundwater contamination at the Site.

SITE BACKGROUND

Site Description

The Site includes a plume of groundwater contaminated with chlorinated volatile organic compounds (VOCs) in an industrial area of Cidra (figure 1). Between March 1996 and August 2000, the Puerto Rico Department of Health (PRDOH) ordered the Puerto Rico Aqueduct and Sewer Authority (PRASA) to close four public supply wells in Cidra due to tetrachloroethene (PCE) contamination. 1,1-Dichloroethene (1,1-DCE) and trichloroethene (TCE) were also detected in these wells. PRASA closed the following public supply wells (figure 2):

- Cidra Well #3 (Planta Alcantarillado), serving 112 people, closed in February 1999
- Cidra Well #4 (Calle Padilla Final), serving 177 people, closed in March 1996
- Cidra Well #6 (Calle Baldorioty), serving 207 people, closed in August 2000
- Cidra Well #8 (Frente Cementerio), not in service, closed in October 1996.

There are 15 active drinking water wells located within four miles of the Site, serving a total population of 8,838 people. The Site encompasses a small plateau and the densely populated Cidra commercial center, which consists of stores, private residences, municipal buildings and the town plaza. The Site also includes a drainage area to the south of the town center where some of the closed municipal wells are located, and the Cidra Industrial Park, which is in a valley to the southeast of the town center.

The Site is located within an ecological zone of Puerto Rico characterized by moist-lowland forest. Another dominant land feature, a large municipal cemetery, is also present.

Site History

As described above, the Site includes four closed municipal wells, the Ramallo property located in the Puerto Rico Industrial Development Company (PRIDCO or FOMENTO in Spanish) Cidra Industrial Park, and a former dry cleaning facility, IDC, located in the commercial district of Cidra.

According to information obtained by EPA, the lot owned by Ramallo was sold as a vacant lot to Sierra Instruments PR, Inc. in 1978. A company called Ramallo Escribano, Inc., (REI) purchased the property from Linear Packaging Inc. (Linear) and operated at that location from September 1986 to August 1990. REI manufactured flexographic labels at the Ramallo property. Ramallo purchased the property from REI in August 1990, at which time REI ceased operations and its company stocks were sold to Ramallo. The Ramallo property has been unoccupied since 2007.

The IDC property is located on Muñoz Rivera Avenue in Cidra, less than 0.1 mile northeast of Cidra Well 4, one of the closed municipal wells. Dry cleaning had been performed at the facility since approximately 1994, although IDC had no RCRA permit on file with EPA during its operations. The ground floor of the building on the IDC property is currently vacant. A residential unit on the second floor is currently occupied.

Topography and Drainage

The municipality of Cidra is located in the central-eastern section of Puerto Rico in the northern foothills of the Cordillera Central Mountain Range. The Cidra commercial district is approximately 1,400 feet above mean sea level (msl). The topography generally slopes south from the commercial district to a narrow southwest-trending valley and an unnamed stream (referred to as the northern drainage area).

In the vicinity of the Cidra Industrial Park, the topography slopes southwest toward the Rio Arroyata. The unnamed stream drains the area surrounding the Cidra municipal cemetery, and flows into the Rio Arroyata southwest of the Site (see figure 1).

In general, most of the surface water drainage from the Site flows south and west across the Site toward the unnamed stream and the Rio Arroyata, a tributary of the La Plata River. Areas to the north and east of the Site drain into Cidra Lake located 0.5 mile east of the Site, which is part of the Bayamon River drainage basin. This lake is a man-made reservoir and is a popular fishing destination. A surface water intake for drinking water is located approximately 2.2 miles downstream of Cidra Lake.

Geology

The geology in the vicinity of the Site is illustrated on the U.S. Geological Survey Comerio Quadrangle geologic outcrop map. The three strata encountered at the Site are the Quaternary-age terrace deposits composed of silt and clay, a saprolite layer (decomposed bedrock), and the underlying Cretaceous-age Pre-Robles volcanic rocks. The units are described below.

Quaternary Upper Silty Clay – This unconsolidated overburden unit consists of reddish-brown silty clay grading to gray and brown silty clay. The depth to the bottom of the silty clay unit varies from 55 feet below the ground surface (bgs) at Saprolite Monitoring Well (SMW) SMW-1 to 105 feet bgs at SMW-2; generally, the silty clay layer is thicker in the area near IDC than in the area near Ramallo.

Saprolite Zone – The saprolite is the result of chemical weathering of the underlying volcanic rocks. The material is a hard, wet, brown to light brown, sandy to silty clay with abundant dark brown to brown, angular to very angular, mafic rock fragments with fine-grained texture. The saprolite crumbles easily under light pressure. Where present, the unit ranges in thickness from 45 feet at Multiport Well (MPW) MPW-2 and MPW-3 to 60 feet at MPW-1. The contact between the saprolite and the underlying bedrock ranges from 109 to 156 feet bgs. At four locations, the depth ranges from 121 to 132 feet bgs.

Pre-Robles Volcanic Rock (Formation J) - The core of the region is comprised of Cretaceous to Early Tertiary volcanic rocks of the Pre-Robles Formation (Formation J), which are the oldest rocks exposed in the Comerio geologic quadrangle. The rocks are estimated to be a maximum of approximately 8,900 feet thick and consist mostly of massive volcanic breccia, although lava flows and flow breccia occur throughout and are more common at the base and top of the unit. Massive to poorly stratified tuffs are interlayered with the volcanic breccia. Locally, volcanic conglomerates outcrop periodically.

The supply wells and the multiport monitoring wells are completed in this unit, and well logs describe it as blue, brown, or black volcanic rock. A rock core collected from 123 to 328 feet bgs revealed volcano-clastic rocks consisting of well-defined dark bluish-gray to dark gray to dark reddish-brown clasts in a green fine-grained matrix with inclusions of light greenish gray and white crystals. Some 1/8 inch to 1/4 inch thick veins (possibly quartz) and 45 degree angle fractures (198 to 199 feet bgs) were observed in the core. Evidence of metamorphism was observed at 202 feet bgs.

Key structural features in the vicinity of the Site include the Arroyata Fault, located 0.25 mile to the south of the commercial district and adjacent to the industrial park. The fault is weathered and has been hydrothermally altered across much of the area to the south of Cidra. Displacement along it is uncertain, but is generally strike-slip with a minor oblique component; it reverses to the east of Cidra.

Hydrogeology

The aquifer of concern at the Site is the Pre-Robles volcanic bedrock that underlies the area. The closed and active wells are finished in this aquifer at depths ranging from 110 to 705 feet bgs. It is the major aquifer beneath the Site.

The Site is immediately underlain by the Quaternary upper silty clays, which overlie the fractured Cretaceous-age Pre-Robles volcanic bedrock. The saprolite zone lies between the silty clays and the bedrock. The hydrogeology of these units is described below.

Hydrogeology of the Upper Silty Clay - Silts and clays have low permeabilities, which tend to hinder groundwater flow through the overburden to the water table. However, the fractures and lineations observed in the silty clays may provide secondary permeability that enhances groundwater flow to the underlying units.

Hydrogeology of the Saprolite Unit - The saprolite zone below the silty clay was observed during the well installation to be a major water-bearing unit; the saprolite stores water and provides recharge to the underlying bedrock aquifer. This unit is semi-confined by the overlying silty clay soils, as evidenced by rising water level conditions in drilling rods upon reaching this zone. During well installation activities, very little water was encountered while drilling through the silty clay unit. Once the saprolite unit and groundwater were encountered, water levels rose approximately 20 feet to 54 feet. Once in this unit, groundwater flows downward and laterally to the west/southwest and enters fractures at the top of the volcanic bedrock.

Hydrogeology of the Pre-Robles Volcanic Rock - Groundwater flow in the bedrock is complicated by fractures and bedding planes and by the Site location relative to the two major river basins. The porosity of the bedrock is only two to three percent, but joints and fractures can enhance groundwater flow considerably. Bedding planes in the bedrock act as individual aquifers, separated by aquitards consisting of relatively low permeability bedrock, where less fracturing is present. Across the majority of the Site (west of the property owned by IVAX Pharmaceuticals, Inc. (IVAX)), groundwater encounters bedding planes in the bedrock aquifer and flows laterally along strike to the north and south and then down dip to the west. The resulting overall groundwater flow is to the west/southwest, toward the Rio Arroyata, located south and west of the Site.

In the vicinity of the IVAX property, which is closer to the Arroyata Fault, bedding planes and fractures strike northwest/southeast, indicating a groundwater divide somewhere on the property. Based on the different strike and dip orientations in this area, groundwater in the bedrock flows to the southeast, toward an unnamed stream southeast of the IVAX property.

Ecological Reconnaissance

Topography and surface water drainage at the Site is to the south/southwest toward the Rio Arroyata and the unnamed stream that drains the area surrounding the Cidra municipal cemetery.

The portion of the Rio Arroyata included in the ecological reconnaissance for this Site can be characterized as a low/moderate gradient stream comprised of various riffle/run/pool sequences no more than three to five feet in width, with depth ranging from a few inches to over a foot in pooled reaches. Stream banks are relatively steep. Debris piles and eroded banks within bends suggest moderate to high flow during precipitation events.

The substrate varies from coarse sand/fine gravel to coarse gravel and cobbles within riffle and run areas; coarse sand comprises the majority of the substrate found in deeper pools, as these are associated with depositional areas along bends. Along the right bank downstream of the Route 171 bridge, several groundwater seeps were observed.

In general, vegetative communities and available habitats are indicative of disturbed conditions, as evidenced by former dilapidated structures and foundations, miscellaneous refuse, surrounding development, and the presence of native and non-native species. The tree canopy cover ranges from 85 to 100 percent within the immediate stream corridor of the Rio Arroyata and drainage swales. With the exception of areas characterized by monotypical stands of bamboo, the understory is dense and consists of various woody and herbaceous vegetative species. No contaminant-derived impacts related to Site contamination appear to be present.

Various wildlife was observed during the ecological reconnaissance, including several bird species, large terrestrial snails, lizards, frogs, and fish species.

Information regarding threatened and endangered species and ecologically sensitive environments that may exist at or in the vicinity of the Site was collected from the United States Fish and Wildlife Service and the Puerto Rico Department of Natural and Environmental Resources (PRDNER).

Based on United States Fish and Wildlife Service records, two federally-listed species (the Puerto Rico boa snake (*Boa puertorriquena*) and the Puerto Rican Plain pigeon (*Paloma sabanera*)) may be found within the municipality of Cidra. Neither species was encountered during the ecological reconnaissance visit.

The PRDNER reported to EPA that a review of their records for the Site and surrounding area indicated no known occurrences of listed rare, threatened, and/or endangered species.

Meteorology

The climate for the Cidra area is classified as tropical humid and is moderated by the nearly constant trade winds that originate in the northeast and its location in the foothills of the Cordillera Central Mountain Range. The average annual temperature for the Cidra area is 72.7 degrees Fahrenheit (°F). Recent Cidra precipitation data indicates an average annual precipitation rate of 65 inches per year.

Demographics and Land Use

The Cidra Municipality is comprised of 36.5 square miles with a population of 43,480 and a population density of 1,200 people per square mile (2010 U.S. Census). Land uses in the Site area include forest (34 percent), agriculture/rural (49 percent), and urban (16 percent). The land within the Site is used for residential, commercial, industrial, manufacturing, and agricultural purposes.

EARLY SITE INVESTIGATIONS

The PRDOH ordered PRASA to close the four public supply wells in the Municipality of Cidra due to the detection of PCE above federal maximum contaminant levels (MCLs). The source of contamination was unknown at the time each well was closed. Several investigations were conducted to identify sources. A brief description of these investigations is provided below.

EPA Expanded Site Inspection/Remedial Investigation, 2002

In June 2002, several groundwater samples were collected by the EPA. Those samples were collected from the closed municipal supply wells and 20 other active and inactive wells located in Cidra. PCE was detected in the closed wells at concentrations ranging from 0.64 to 12 micrograms per liter (µg/L). PCE was also detected in two industrial/potable supply wells (IVAX No. 1 and No. 2) and three industrial wells (Glaxo Smith Kline No. 1 and No. 2 and Millipore - Cidra). Related chlorinated solvents, including 1,1-DCE, 1,1-dichloroethane, cis-1,2-dichloroethene (cis-1,2-DCE), carbon tetrachloride and TCE were also detected in groundwater samples.

Federal MCLs for PCE (5 µg/L) and 1,1-DCE (7 µg/L) were exceeded in a number of wells tested, though not in any of the active drinking water wells. Other VOCs were also detected, in most cases at estimated concentrations below the sample quantitation limits. The investigation concluded that detections in the Glaxo Smith Kline wells and Millipore-Cidra industrial wells located east of Cidra Lake are likely not associated with the VOC source that impacted the closed public water supply wells.

EPA Potential Source Area Investigation, 2003

In January and February 2003, the EPA investigated 12 industrial sites in the Cidra area to determine if they could be potential sources of contamination in the groundwater. Based on this investigation, EPA identified properties that required further investigation as part of the RI.

EPA RI/FS - 2007-2013

An RI for the Site was conducted from July 2007 through June 2012. The overall purpose of the RI was to identify potential source areas through soil, vapor intrusion and groundwater investigations, define the hydrogeologic framework, evaluate the nature and extent of groundwater, soil, soil vapor, surface water, and sediment contamination, and develop appropriate remedial alternatives for the identified contamination. The vapor intrusion investigation was conducted to determine the potential of vapor accumulation in the subslabs of structures and to determine if vapors have gained access to indoor air. Due to the lack of existing hydrogeological data and the lack of a defined source of contamination, a staged field investigation was planned to effectively use data collected during initial stages to focus and refine data collection activities in the following stages. An FS was prepared to present and analyze cleanup alternatives suitable for the Site. The purpose of the FS was to identify, develop, screen, and evaluate a range of remedial alternatives for the contaminated media. The FS report provided the regulatory agencies with data sufficient to select a feasible and cost-effective remedial alternative that protects human health and the environment from potential risks at the Site.

NATURE AND EXTENT OF CONTAMINATION

The nature and extent of contamination in Site media was assessed during the RI by collecting and analyzing samples and then comparing analytical results to federal, Commonwealth, and Site-specific screening criteria. Five chemicals were identified as Site-related contaminants: PCE, TCE, cis-1,2-DCE, 1,1-DCE, and vinyl chloride. These chemicals were chosen based on the frequency and magnitude of screening criteria exceedances and previous detections in the supply wells. These chemicals also represent degradation products of chlorinated solvents. The RI also investigated the Site for the presence of Site contaminants in the form of nonaqueous phase liquids (NAPLs). Site contaminants are chlorinated VOCs that are denser than water, so are also referred to as dense nonaqueous phase liquids (DNAPLs).

As part of the RI, soil, groundwater, and/or soil vapor were sampled at numerous locations at the Site. Sampling was conducted at the following properties in the commercial section of Cidra: Don Quixote Pizza, Ramoncito (a sporting goods store) and a coffee shop, all of which were locations of former dry cleaning operations, an ESSO gas station, and IDC.

At the PRIDCO Cidra Industrial Park, soil, groundwater, and/or soil vapors samples were collected at Ramallo, CCL Label de Puerto Rico (CCL), ENCO Manufacturing, Inc. (ENCO), DJ Manufacturing, Inc., IVAX Pharmaceutical Caribe, Inc. (IVAX), Pepsi Co. Inc. (Pepsi), and Shellfoam Products, Inc. (Shellfoam).

The results of the sampling events are discussed below.

Summary of Soil Contamination

- Site-related VOCs were detected in soil samples at IDC, Ramallo, CCL, ENCO, DJ Manufacturing, Inc., Don Quixote Pizza, and ESSO (figure 2). VOCs only exceeded screening criteria at IDC and Ramallo.

- No VOCs were detected at the Coffee Shop or Ramoncito (figure 2). A few VOCs were detected at IVAX, Pepsi, and Shellfoam facilities, but at levels below screening criteria and none were Site-related.

- The main source of contamination in the southern area of the Site is a hot spot at the Ramallo facility with the highest levels of Site-related contaminants (PCE at 3,300,000 micrograms per kilogram (µg/kg) and TCE at 2,700 µg/kg) found in shallow soils (0-4 feet bgs) in the northeastern portion of the property (figure 3). No visual evidence of NAPL was observed in the soil samples.

- The highest levels of Site-related contaminants in the northern area hot spot were found at IDC, the main source of contamination in the northern area of the Site. PCE at a concentration of 1,700,000 µg/kg, TCE at 39,000 µg/kg, as well as cis-1,2-DCE (29,000 µg/kg), and vinyl chloride (1,200 µg/kg) were found at IDC (figure 4).

Summary of Soil Vapor Contamination

Since volatilization is an important transport process for chlorinated VOCs in soil, vapor intrusion (VI) poses a potential exposure pathway at Ramallo and IDC due to the high soil concentrations.

- PCE and TCE were present in subslab soil vapor at concentrations several orders of magnitude higher than their respective screening levels at both IDC and Ramallo.

- Site-related VOCs were detected in subslab soil gas samples at several buildings near IDC and Ramallo, indicating that Site-related VOCs have migrated in the subsurface to buildings near the source areas. Although Site-related VOCs were detected in the subslab or indoor air at these nearby buildings, concentrations were detected below screening levels.

- TCE was also detected in ambient air samples upwind of both Ramallo and IDC facilities. These detections were also below the screening level. This ambient measurement is not Site-related.

- At least one non-Site-related VOC (including benzene, carbon tetrachloride, chloroform, 1,2-dichloroethane, 1,4-dichlorobenzene, 1,2-dichloropropane, ethylbenzene, and 1,1,2,2-tetrachloroethane) was detected at levels above their respective screening level, in indoor air at each structure sampled. The presence, concentrations, and distribution of VOCs in the subsurface within these structures, and in ambient air indicate that VOC exceedances are mostly attributable to indoor sources and background levels and not from vapor intrusion of Site contaminants.

Summary of Groundwater Contamination

- Site-related contaminants exceeded screening criteria only in the monitoring wells in the southern portion of the Site (i.e., in the areas of Ramallo, CCL Label, and Shellfoam). No exceedances of screening criteria were found in any of the wells north of the industrial park.

- The groundwater contamination in the southern area originates at Ramallo and extends southwest to the Rio Arroyata (figure 5).

- Overall, the highest levels of Site-related contaminants in groundwater (PCE concentrations of 680 to 1,700 µg/L and TCE concentrations of 14 to 31 µg/L) were detected in the saprolite wells located at and downgradient of Ramallo (SMW-1 and SMW-10), respectively (figure 5).

- Monitoring well MPW-5 had the highest levels and the most PCE exceedances in bedrock, with a maximum of 120 µg/L at 260 to 274 feet bgs. TCE follows a similar pattern with the highest concentration of 5.3 µg/L.

- As shown in figure 5, the PCE plume extends to the Rio Arroyata, as evidenced by levels exceeding screening criterion in saprolite wells SMW-6 and SMW-7 and at levels below the screening criterion in the Rio Arroyata surface water samples SW-5 and SW-6.

Lower levels (below screening criteria) were also found side gradient of Ramallo at SMW-4 and not detected in SMW-5, which indicates that the plume is relatively narrow in that area.

- In the bedrock, Site-related contaminants exceeded screening criteria in MPW-1, located adjacent to SMW-1, and MPW-5, located east of Ramallo near the closed supply well Cidra #8. MPW-5 had the highest levels and the most PCE exceedances in the five deepest ports, with a maximum level of 120 µg/L in port 5 (260 to 274 feet bgs) as shown in figure 5.

- No DNAPLs have been directly observed in soil or groundwater at the Site. However, at both IDC and Ramallo, elevated concentrations of Site-related VOCs were detected in the vadose zone at concentrations that exceeded the soil saturation limit for PCE of 166 milligrams per kilogram (mg/kg), indicating the potential presence of DNAPL.

Summary of Surface Water/Sediment Contamination

- Groundwater in the saprolite zone is hydraulically connected to the Rio Arroyata. The contaminant plume originating at Ramallo extends to the Rio Arroyata.

- PCE, TCE, and cis-1,2-DCE were found at detectable levels, although below their respective screening criteria, in samples collected from the Rio Arroyata. PCE was the most frequently detected contaminant. PCE was detected in SW-5 through SW-10, with the highest levels in SW-6 (4 µg/L), SW-7 (4.6 µg/L) and SW-8 (4.1 µg/L), as shown in figure 6. These locations are bounded by lower concentrations in SW-5 (2 µg/L), SW-9 (1.8 µg/L) and SW-10 (2.1 µg/L). TCE was detected in SW-7 at a concentration of 0.25 J µg/L. Cis-1,2 DCE was also detected in samples SW-5 (0.27 µg/L), SW-6 (0.58 µg/L) and SW-7 (0.65 µg/L). No Site-related contaminants were detected in surface water samples SW-1 (up gradient sample), SW-2, SW-3, or SW-4.

- PCE was detected in one sediment sample (SD-9) collected from the Rio Arroyata at 1.9J µg/kg, below the screening criteria, as shown in figure 6.

SUMMARY OF SITE RISKS

The purpose of the risk assessment is to identify potential cancer risks and non-cancer health hazards at the Site assuming that no further remedial action is taken. A risk assessment was performed to evaluate current and future cancer risks and non-cancer health hazards based on the results of the RI.

A screening-level ecological risk assessment was also conducted to assess the risk posed to ecological receptors due to Site-related contamination.

Human Health Risk Assessment

As part of the RI, a baseline human health risk assessment (HHRA) was conducted to estimate current and future effects of contaminants on human health and the environment. A baseline HHRA is an analysis of the potential adverse human health effects caused by hazardous-substance exposure in the absence of any actions to control or mitigate these exposures under current and future land uses. In the HHRA for the Site, a four-step human health risk assessment process was used for assessing Site-related cancer risks and noncancer health hazards. The four-step process is comprised of: Hazard Identification of Chemicals of Potential Concern (COPCs), Exposure Assessment, Toxicity Assessment, and Risk Characterization (see adjoining box “What is Risk and How is it

WHAT IS RISK AND HOW IS IT CALCULATED?

Human Health Risk Assessment:
A Superfund baseline human health risk assessment is an analysis of the potential adverse health effects caused by hazardous substance releases from a site in the absence of any actions to control or mitigate these under current- and future-land uses. A four-step process is utilized for assessing site-related human health risks for reasonable maximum exposure scenarios.

Hazard Identification: In this step, the chemicals of potential concern (COPCs) at the site in various media (*i.e.*, soil, groundwater, surface water, and air) are identified based on such factors as toxicity, frequency of occurrence, and fate and transport of the contaminants in the environment, concentrations of the contaminants in specific media, mobility, persistence, and bioaccumulation.

Exposure Assessment: In this step, the different exposure pathways through which people might be exposed to the contaminants in air, water, soil, etc. identified in the previous step are evaluated. Examples of exposure pathways include incidental ingestion of and dermal contact with contaminated soil and ingestion of and dermal contact with contaminated groundwater. Factors relating to the exposure assessment include, but are not limited to, the concentrations in specific media that people might be exposed to and the frequency and duration of that exposure. Using these factors, a “reasonable maximum exposure” scenario, which portrays the highest level of human exposure that could reasonably be expected to occur, is calculated.

Toxicity Assessment: In this step, the types of adverse health effects associated with chemical exposures, and the relationship between magnitude of exposure and severity of adverse effects are determined. Potential health effects are chemical-specific and may include the risk of developing cancer over a lifetime or other non-cancer health hazards, such as changes in the normal functions of organs within the body (*e.g.*, changes in the effectiveness of the immune system). Some chemicals are capable of causing both cancer and non-cancer health hazards.

Risk Characterization: This step summarizes and combines outputs of the exposure and toxicity assessments to provide a quantitative assessment of site risks for all COPCs. Exposures are evaluated based on the potential risk of developing cancer and the potential for non-cancer health hazards. The likelihood of an individual developing cancer is expressed as a probability. For example, a 10^{-4} cancer risk means a “one-in-ten-thousand excess cancer risk”; or one additional cancer may be seen in a population of 10,000 people as a result of exposure to site contaminants under the conditions identified in the Exposure Assessment. Current Superfund regulations for exposures identify the range for determining whether remedial action is necessary as an individual excess lifetime cancer risk of 10^{-4} to 10^{-6}, corresponding to a one-in-ten-thousand to a one-in-a-million excess cancer risk. For non-cancer health effects, a “hazard index” (HI) is calculated. The key concept for a non-cancer HI is that a “threshold” (measured as an HI of less than or equal to 1) exists below which non-cancer health hazards are not expected to occur. The goal of protection is 10^{-6} for cancer risk and an HI of 1 for a non-cancer health hazard. Chemicals that exceed a 10^{-4} cancer risk or an HI of 1 are typically those that will require remedial action at the site and are referred to as Chemicals of Concern or COCs in the final remedial decision or Record of Decision.

Calculated” for more details on the risk assessment process).

Chemicals of potential concern were selected by comparing the maximum detected concentration of each analyte in site media with available risk-based screening values. Media evaluated included soil, groundwater and surface water and sediment from the nearby river (Rio Arroyata). The Cidra Site is located just south of the main commercial district of the Cidra Municipality in central eastern Puerto Rico. The Cidra Municipality is comprised of 36.5 square miles with a population of 43,480 and a population density of 1,200 people per square mile (2010 U.S. Census). Land use for the Cidra Site area includes forest (34 percent), agriculture/rural (49 percent), and urban (16 percent). The Site is currently zoned for residential and commercial/industrial use. Potential exposure pathways for the Site were defined based on current and potential future land uses of the Site. Based on the RI results, the Site was divided into the following four exposure areas (EAs) for soil for the risk evaluation.

- Exposure Area 1: Ramoncito, Don Quijote Pizza, Coffee Shop, and ESSO Gas Station/LM Auto Parts (ESSO).
- Exposure Area 2: IDC.
- Exposure Area 3: CCL Label, Ramallo Property, and ENCO.
- Exposure Area 4: Shellfoam, DJ Manufacturing, IVAX facility, and Pepsi.

Potential receptors evaluated under the current land use scenario included workers in EA 2 through 4, trespassers in EA 2, and residents in EA 2. EA 1 was not considered for current exposure because it is paved and there in no current exposure. Potential receptors under the future land use scenario included residents, workers, trespassers and construction workers in all exposure areas.

Exposure pathways for soil included incidental ingestion, dermal contact, and inhalation of particulates and volatiles released from soil by residents, workers, trespassers, and construction workers. Exposure pathways evaluated for groundwater included ingestion for future Site workers, and ingestion, dermal contact, and inhalation (vapor released during showering and bathing) by future residents. Additionally, future residents were evaluated for the potential exposure to volatile COPCs via inhalation of vapors emanating from groundwater into enclosed structures (i.e., vapor intrusion). Exposure pathways for surface water and sediment included incidental ingestion and dermal contact by recreational users of the Rio Arroyata.

For current receptors, estimated cancer risks and non-cancer hazards for Site-related contaminants were below or within EPA's target threshold (cancer risk of 1×10^{-6} to 1×10^{-4} and non-cancer Hazard Index [HI] of 1) for all EAs.

With the exception of workers (2×10^{-4}) and residents (1×10^{-3}), the estimated total cancer risks for future receptors in each exposure area were either below or within EPA's target range of 1×10^{-6} to 1×10^{-4}. The noncancer health hazard for future residents ranged from 80 to 93 in the varying EAs. The potential health hazards are associated with the following Site- related chemicals of concern: PCE and TCE in groundwater and PCE in EA 3 soils. Future workers in EA 3 have a noncancer HI of 10. The potential non-cancer health hazards are mostly attributed to PCE in soil.

A vapor intrusion (VI) investigation in nearby buildings potentially affected by Site related contamination was conducted. The results of the investigation are discussed in the "Summary of Soil Vapor Contamination," above. For overall completeness of the HHRA, a qualitative VI screening level evaluation was conducted. Results of the screening assessment indicated the VI-related COPCs correlate to those identified in the groundwater screening process (i.e., concentrations in groundwater exceed VI risk-based groundwater screening levels).

Ecological Risk Assessment

A screening-level ecological risk assessment (SLERA) was conducted to evaluate the potential for ecological risks from the presence of contaminants in surface water and sediment. The SLERA focused on evaluating the potential for impacts to sensitive ecological receptors to Site-related constituents of concern through exposure to surface water and sediment that receive groundwater discharge from the plume. Surface water and sediment concentrations were compared to ecological screening values as an indicator of the potential for adverse effects to ecological receptors. A complete summary of all exposure scenarios can be found in the SLERA.

All of the contaminants that were detected, including chemicals which were later considered to be non-Site related in surface water and sediments, were compared to conservatively derived ecological screening values. There were several compounds that exceeded an HQ of 1, specifically, aluminum, barium, lead and manganese in surface water and chromium, copper, cyanide, iron, manganese, mercury and nickel in sediments. However, none of the Site-related contaminants (i.e., TCE, PCE and their breakdown products) exceeded their respective screening values. The metals that were detected are not considered to be Site-related. Since no Site-related contaminants were above the conservative screening values, there is no unacceptable ecological risk from the Site and, therefore, no action is needed for the sediment or surface water and current Site-related conditions are protective of ecological receptors.

Conclusion

Based on the results of the RI and the risk assessments, EPA has determined that the remedy identified in this Proposed Plan, or one or more of the other active measures considered, is necessary to protect public health, welfare or the environment from actual or threatened releases of hazardous substances into the environment.

REMEDIAL ACTION OBJECTIVES

Remedial action objectives (RAOs) are specific goals to protect human health and the environment. These objectives are based on available information and standards, such as applicable or relevant and appropriate requirements (ARARs), to-be-considered (TBC) guidance and site-specific risk-based levels.

EPA has established expectations to use treatment to address any principal threats posed by a site. Principal threat wastes are those source materials considered to be highly toxic or mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur. At both IDC and Ramallo, elevated concentrations of Site-related VOCs were detected in the vadose zone at levels indicating the presence of DNAPL. PCE and, to a lesser extent, other contaminants have migrated to the saprolite and the bedrock aquifers at Ramallo. Therefore, PCE contamination in the vadose zone fits the definition of principal threat waste and would require remediation through treatment, where practicable.

The media of concern at the Site are soil and groundwater. The source of soil contamination in the southern area of the Site is Ramallo and in the northern area of the Site is IDC. The groundwater contamination is located in the southern portion of the Site and based on the results of the RI, originates at Ramallo. Soil vapor samples show elevated soil vapor under the building slabs at both IDC and Ramallo, although there is currently no exposure because Ramallo is unoccupied and the lowest floor of IDC is unoccupied. Actions would be required if these spaces were to be occupied in the future.

Site-related contaminants include PCE , TCE, cis-1,2-DCE, 1,1-DCE, and vinyl chloride. These contaminants may pose risks to human health through inhalation, ingestion, and dermal contact.

RAOs are media-specific goals for protecting human health and the environment and serve as guidance for the development of remedial alternatives. To protect human health and the environment, RAOs have been identified.

The RAOs for soil are:

- Prevent contaminated soil at the Site from serving as a source of groundwater contamination by isolating or remediating soil with contaminant concentrations exceeding groundwater protection remediation goals, discussed further below.

- Prevent human exposure to contaminated soil at the Site having contaminant concentrations in excess of the remediation goals.

The RAO for soil vapor is:

- Prevent or minimize impacts to public health resulting from the potential for soil vapor intrusion into buildings at and around IDC and Ramallo.

The RAOs for groundwater are:

- Prevent human exposure to contaminant concentrations in groundwater above levels that are protective of drinking water.

- Restore the groundwater to drinking water quality to the extent practicable.

REMEDIATION GOALS

To meet the RAOs, remediation goals were developed to aid in defining the extent of contaminated soil and groundwater requiring remedial action. Remediation goals are chemical-specific measures for each media and/or exposure route that are expected to be protective of human health and the environment. They are derived based on comparison to ARARs, risk-based levels, and background concentrations, with consideration also given to other requirements such as analytical detection limits, guidance values, and other pertinent information.

Remediation Goals for Soil

No Federal or Commonwealth chemical-specific ARARs were identified for soil. Therefore, EPA's risk-based Regional Screening Levels were identified as TBC criteria. Since promulgated standards do not exist for the Site-related contamination in soil, remediation goals for soil were derived based on protection of groundwater for the Site and risks to human health from PCE, whichever is lower. The contaminant cleanup level for protection of groundwater from PCE is more conservative than the contaminant cleanup level based on human health risk.

Soil cleanup levels are set to be protective of groundwater. The soil remediation goals were calculated using a Site-specific soil-partitioning coefficient and the standard Dilution-Attenuation Factor (DAF) of 20. The DAF considers dilution and attenuation factors that reduce contaminant concentrations in soil leachate during migration through the vadose zone. Table 1 (found at the end of this Proposed Plan) contains the remediation goals for soil based on impact to groundwater quality.

Screening Criteria for Vapor Intrusion

Federal vapor intrusion guidance was identified, in the form of suitable subslab contaminant screening criteria and indoor air concentrations requiring mitigation developed by EPA. The subslab screening criteria and indoor air concentrations requiring mitigation are presented in table 2. PCE and TCE were present in subslab soil vapor at concentrations several orders of magnitude higher than their respective screening levels at both the IDC and Ramallo property source areas. These are the only lots where VI response actions are currently contemplated.

Remediation Goals for Groundwater

Groundwater at the Site is classified as SG (which includes all groundwaters as defined in Puerto Rico Water Quality Standards Regulation), suitable for drinking water use, and was historically used as a source of potable water supply. In order to accommodate any future use of Site groundwater as a source of potable water supply, federal drinking water standards are relevant and appropriate requirements. Puerto Rico Water Quality Standards (PRWQS) Regulation for surface water discharges, which are TBCs, will be considered for groundwater if remedial alternatives under consideration entail any discharges to waters of Puerto Rico. Table 3 presents the remediation goals for groundwater.

SUMMARY OF REMEDIAL ALTERNATIVES

CERCLA § 121(b)(1), 42 U.S.C. § 9621(b)(1), mandates that remedial actions must be protective of human health and the environment, be cost-effective, and utilize permanent solutions and alternative treatment technologies and resource recovery alternatives to the maximum extent practicable. Section 121(b)(1) also establishes a preference for remedial actions which employ, as a principal element, treatment to permanently and significantly reduce the volume, toxicity, or mobility of the hazardous substances, pollutants and contaminants at a site. CERCLA § 121(d), 42 U.S.C. § 9621(d), further specifies that a remedial action must attain a level or standard of control of the hazardous substances, pollutants, and contaminants, which at least attains ARARs under federal and state laws, unless a waiver can be justified pursuant to CERCLA § 121(d)(4), 42 U.S.C. § 9621(d)(4).

The time frames presented below for each alternative reflect only the time required to construct or implement the remedy and do not include the time required to design the remedy, negotiate the performance of the remedy with any potentially responsible parties, or procure contracts for design and construction.

The cost estimates, which are based on available information, are order-of-magnitude engineering cost estimates that are expected to be within +50 to -30 percent of the actual cost of the project.

Alternatives were grouped by media and area as follows:

- Soil at IDC.
- Soil at Ramallo.
- Groundwater under and downgradient of Ramallo.

<u>Common Elements</u>

There are several common elements that are included in all active remedial alternatives. With the exception of five-year reviews, the common elements listed below do not apply to the No Action alternatives.

Pre-Design Work

A structural survey of the buildings at and surrounding IDC and Ramallo would be conducted to evaluate the structural stability during and after remediation.

Vapor Mitigation Systems

An additional component included in all alternatives (except the no action alternative) is the installation, operation and maintenance (O&M) of one or more vapor mitigation systems to address any VI concerns based on pre-design VI sampling at and near IDC and Ramallo. The IDC and Ramallo properties are the only locations where response actions are currently contemplated, and these properties are currently vacant (with the exception of a second floor residence at IDC, which is not affected by VI). They could be occupied in the future. The steps described below would be triggered by occupancy. Occupancy would initiate collection of several rounds of samples at each building, including subslab and indoor air samples. If vapor sampling indicates the presence of vapors exceeding the air criteria, a vapor mitigation system would be installed. A one-time inspection of the vapor mitigation system would be conducted to ensure that the system is working properly.

For cost estimating purposes, it is estimated that two vapor mitigation systems would be installed. Following installation, these systems would be monitored to ensure proper performance.

Currently, only additional VI monitoring is contemplated for properties near IDC and Ramallo.

Institutional Controls

Institutional controls (ICs) would restrict the future use of the soil at IDC and Ramallo and groundwater under and downgradient of Ramallo until cleanup has been achieved. The types of institutional controls employed would include proprietary controls (e.g., easements/covenants) on all or parts of IDC and Ramallo to prevent use of Site areas that would pose an unacceptable risk to receptors. In addition, the groundwater-use restriction within the existing plume will be implemented by the government of Puerto Rico to prevent well installation. Other types of institutional controls (e.g., warning signs, advisories, and public education) would also be employed to limit exposures to soil contamination.

More information about Institutional Controls can be found at: http://www.epa.gov/fedfac/pdf/ic_ctzns_guide.pdf

Long-term Monitoring

Periodic monitoring of Site groundwater would be implemented when contaminants remain above levels that allow for unrestricted use and unlimited exposure. The monitoring program would continue until concentrations have met remedial goals. Long-term monitoring is the only remedial action suggested for groundwater contamination at the IVAX facility. Since the observed 1,1-DCE concentrations are only slightly above remediation goals, it would not be cost effective to treat this contamination. In addition, it would be prudent to monitor the Rio Arroyata surface water for impacts to water quality while a groundwater remedy is being implemented.

Five-Year Reviews

Alternatives resulting in contaminants remaining above levels that allow for unrestricted use and unlimited exposure, require that the Site be reviewed at least once every five years. If justified by the review, additional remedial actions may be considered to remove, treat, or contain the contamination.

For remedial actions where unrestricted use and unlimited exposure is the remedial objective, it may require many years to reach that objective. It is EPA policy to conduct five-year reviews until remediation goals are achieved.

EPA Region 2 Clean and Green Policy

The environmental benefits of the preferred remedy may be enhanced by giving consideration, during the design, to technologies and practices that are sustainable in accordance with EPA Region 2's Clean and Green Energy Policy.[1] This will include consideration of green remediation technologies and practices. Some examples of practices that would be applicable are those that reduce emissions of air pollutants, minimize fresh water consumption, incorporate native vegetation into revegetation plans, and consider beneficial reuse and/or recycling of materials, among others.

Soil Remedial Alternatives

Remedial alternatives were assembled by combining the retained remedial technologies and process options for each contaminated media. Because there are only very low levels of groundwater contamination at IDC, less aggressive treatment technologies are proposed for that property, as opposed to the Ramallo property where more aggressive treatment is proposed in order to reduce the impact to groundwater.

Soil Alternatives for IDC

Alternative IDC-S1 – No Action

Capital Cost	$0
Present Worth O&M Cost	$0
Total Present Worth Cost	$0
Timeframe to meet RAOs	Will not meet RAOs

The No Action alternative is required by the NCP to be carried through the screening process. The No Action alternative would include no action being taken and serves as a baseline for comparison of remedial alternatives.

Alternative IDC-S2 – Containment

Capital Cost	$59,000
Present Worth O&M Cost	$46,000
Total Present Worth Cost	$205,000
Construction Time Frame	4 months
Timeframe to meet RAOs	Greater than 30 years

A cap would be installed at IDC in unpaved areas where rainwater may infiltrate into the contaminated soils. The existing concrete slab and building at IDC would serve to cap contaminated soils underlying that building. The purpose of these caps would be to reduce rainwater infiltration as much as possible and thus prevent any further infiltration-induced migration of contaminants in the vadose zone. However, contaminant concentrations in soil may slowly reduce over time (decades to centuries) due to biodegradation and volatilization.

For cost-estimating purposes, it is assumed that the cap would consist of concrete over the existing clay soil. Regular monitoring and maintenance of the cap would be required in perpetuity, as well as institutional controls to prevent disturbance of the cap and the building

[1]See http://epa.gov/region2/superfund/green_remediation.

as well as to prevent any incompatible uses of IDC in the future.

Alternative IDC-S3 – Soil Vapor Extraction and Containment

Capital Cost	$1,239,000
Present Worth O&M Cost	$556,000
Total Present Worth Cost	$1,795,000
Construction Time Frame	6 months
Timeframe to meet RAOs	10 years

Under this alternative, the contaminated area would be targeted with soil vapor extraction (SVE), and capping would be implemented in all other areas at IDC, as described above for Alternative IDC-S2. Regular monitoring and maintenance of the cap would be required in perpetuity, as well as institutional controls to prevent disturbance of the cap and the building as well as any incompatible uses of IDC in the future. For cost-estimating purposes, it is assumed that the contaminated area in the alleyway, approximately 100 square feet and 20 feet deep, would be treated using SVE. The areal extent of the principal threat wastes to be treated with SVE would be refined during pre-design work.

After the pre-design investigation, a pilot scale field air permeability test would be conducted to determine the achievable air flow rate, the required vacuum to induce the flow, the radius of influence from the applied vacuum, and the initial contaminant removal rates.

The current configuration of the IDC building is too low and narrow for a drill rig to enter into the remediation target zone. During the remedial action, an opening through the building wall leading to the alley would be made to provide access to the alleyway. Access doorways would be created on the building front and side to provide access.

Since the IDC soil is predominantly low-permeability clay, air flow through the soil is expected to be low and treatment with SVE is likely to require closely spaced wells. The compressor for the system and a vapor treatment system would be installed in the IDC building. It is anticipated that the system would run for approximately 10 years. Capping would still need to be relied upon to meet soil RAO for direct contact over the long term.

For cost-estimating purposes, it is assumed that three vapor extraction wells and two air injection wells would be installed and the SVE system would be operated for approximately 10 years.

Soil Alternatives for Ramallo

Alternative Ramallo-S1 – No Further Action

Capital Cost	$0
Present Worth O&M Cost	$0
Total Present Worth Cost	$0
Construction Time Frame	0 years
Timeframe to meet RAOs	Will not meet RAOs

The No Action alternative is required by the NCP to be carried through the screening process. The No Action alternative would include no action being taken and serves as a baseline for comparison of remedial alternatives.

Alternative Ramallo-S2 – Containment

Capital Cost	$299,000
Present Worth O&M Cost	$70,000
Total Present Worth Cost	$369,000
Construction Time Frame	4 months
Timeframe to meet RAOs	Greater than 30 years

In the same manner as described for the IDC-S2 capping alternative above, a cap would be installed at Ramallo on the unpaved areas where rainwater may infiltrate into contaminated soils, and the existing building would function to cap the underlying contaminated soils. Repairs would be made to the existing concrete cover within the building floor and areas outside, if it is determined that an opening exists that allows infiltration of water. Regular monitoring and maintenance of the cap would be required in perpetuity, as well as institutional controls to prevent disturbance of the cap and the building as well as to prevent any incompatible uses of Ramallo in the future.

Alternative Ramallo-S3 – Soil Vapor Extraction and Thermal Treatment; Excavation, Disposal, and Backfill; and Containment

Capital Cost	$3,664,000
Present Worth O&M Cost	$70,000
Total Present Worth Cost	$3,734,000
Construction Time Frame	2 years
Timeframe to meet RAOs	2 years inside the treatment zone, greater than 30 years in the capped area.

For this alternative, SVE would be enhanced by thermal heating of the treatment zone. A hollow stem auger would be used inside and outside the building to advance combined SVE wells and heating electrodes to the bottom of the treatment zone on approximately 20-foot centers. The electrical equipment, compressor for the system and the vapor and condensate treatment system would be located at Ramallo. Because high levels of PCE were detected in surface soil, this surface soil contamination would be excavated and properly disposed of off-Site in a permitted landfill. The extent of PCE excavation would be determined during remedial design.

A cap would then be installed across the extent of the remediation target zone to minimize infiltration of rainwater into the contaminated soil. Regular monitoring and maintenance of the cap would be required in perpetuity, as well as institutional controls to prevent disturbance of the cap and the building as well as to prevent any incompatible uses of Ramallo in the future.

Alternative Ramallo-S4 – *In-situ* Treatment and Containment

Capital Cost	$1,785,000
Present Worth O&M Cost	$70,000
Total Present Worth Cost	$1,855,000
Construction Time Frame	1 year
Timeframe to meet RAOs	10 years inside the treatment zone, greater than 30 years in the capped area.

Under this alternative, *in-situ* chemical treatment would be used to remediate high-concentration soil, and the remainder of the soil at Ramallo would be capped. Amendments would be introduced to provide a carbon source for further growth of dehalogenating microbes. Several types of amendments and amendment delivery processes could be utilized. The specific amendment and delivery process would be confirmed during the design of the remedy. For alternative development and cost-estimating purposes, a combined In-Situ Chemical Reduction (ISCR)/bioremediation amendment was selected because it is long-lasting and would also promote abiotic degradation.

Amendments would be introduced with mechanical mixing in the surface soils, and the amendments would be distributed with environmental hydraulic fracturing to deeper soil intervals since injection alone in the low permeability clay would be ineffective. Environmental hydraulic fracturing would not be performed in the first 10 feet to avoid damaging nearby building foundations. Environmental hydraulic fracturing would introduce more moisture to enhance biological growth.

A cap would be installed across the extent of the remediation target zone to minimize infiltration of rainwater into the contaminated soil. Regular monitoring and maintenance of the cap would be required in perpetuity, as well as institutional controls to prevent disturbance of the cap and the building as well as any incompatible uses of Ramallo in the future.

Groundwater Alternatives

The remedial alternatives to address groundwater contamination at the Site are summarized below. Groundwater alternatives are focused on the identified plume in the southern area of the Site since no plume was identified in the northern part of the Site. The groundwater contamination in the southern area originates at Ramallo and extends southwest to the Rio Arroyata.

Alternative GW-1 – No Action

Capital Cost	\$0
Present Worth O&M Cost	\$0
Total Present Worth Cost	\$0
Construction Time Frame	0 years
Timeframe to meet RAOs	Will not meet RAOs.

The No Action alternative is required by the NCP to be carried through the screening process. The No Action alternative would include no action being taken and serves as a baseline for comparison of remedial alternatives.

Alternative GW-2 – Groundwater Extraction, Treatment, and Long-term Monitoring

Capital Cost	\$3,032,000
Present Worth O&M Cost	\$6,389,000
Total Present Worth Cost	\$9,421,000
Construction Time Frame	1 year
Timeframe to meet RAOs	30 years in the treatment zone

Under this alternative, the groundwater contaminant plume under and downgradient of Ramallo would be targeted for remediation. Because PCE is the most wide-spread groundwater contaminant, groundwater extraction and treatment would be implemented in both the saprolite and the bedrock aquifers within the 5 µg/L PCE plume isocontour (the entire groundwater plume). Groundwater extraction would remove the VOCs from the aquifer and also create a hydraulic barrier to further contaminant migration vertically into the bedrock and horizontally downgradient of Ramallo. Extraction and treatment would continue until the aquifer has been restored. Long-term groundwater monitoring of contaminants in the saprolite and bedrock aquifers would be performed to assess remedial action performance.

The groundwater treatment system would include air stripping of the VOCs. Air stripping involves the mass transfer of volatile contaminants from water to air by increasing the surface area of the groundwater exposed to air. Prior to release to the air, the VOCs would be treated. Given the presence of low levels of vinyl chloride, the vapor phase treatment train for the air stripper off-gas would first remove PCE and TCE with granular activated carbon, followed by treatment with potassium permanganate oxidation to remove cis-1,2-DCE and vinyl chloride. It is assumed that the water effluent from the air stripper would be polished with activated carbon to meet PRWQS and then discharged to the Rio Arroyata. For costing purposes, it was assumed that the treatment system would operate for 30 years.

Alternative GW-3 – Focused Groundwater Extraction, Treatment, and Long-term Monitoring

Capital Cost	\$2,715,000
Present Worth O&M Cost	\$6,166,000
Total Present Worth Cost	\$8,881,000
Construction Time Frame	1 year
Timeframe to meet RAOs	30 years in the treatment zone

Under this alternative, groundwater extraction and treatment would be the same technologies as Alternative GW-2 but would be implemented in the saprolite aquifer inside a focused area (200 µg/L contour). While not capturing the entire plume, focused groundwater pumping has the potential to be more effective than pumping the entire plume by removing the higher concentrations at its center. The fringe areas of the plume would be allowed to attenuate naturally over time, a process that would be enhanced by removing the most elevated levels. The exact area would be confirmed during the remedial design phase based upon groundwater modeling.

Groundwater modeling and a focused lateral extent of the 200 μg/L contour plume were used to develop the basis for the total flow rate, the number of pumping wells needed, and preliminary considerations regarding well locations. Based upon the results of modeling, the use of two extraction wells (one near the Ramallo source area and one downgradient near the end of the plume) was considered for this alternative.

For areas outside of the extraction and treatment zone, long-term monitoring of the saprolite and bedrock aquifers would be performed to assess contaminant concentrations over time. It is assumed that contaminated saprolite and bedrock groundwater that is beyond the capture zone of the extraction well system would be allowed to continue migrating and attenuating.

For costing purposes, it was assumed that the treatment system would operate for 30 years.

Alternative GW-4 – *In-situ* Treatment and Long-term Monitoring

Capital Cost	$4,828,000
Present Worth O&M Cost	$2,547,000
Total Present Worth	$7,375,000
Construction Time Frame	2 years
Timeframe to meet RAOs	10 years in the treatment zone

In the saprolite aquifer, *in-situ* treatment would be implemented under this alternative within a focused isocontour that would be determined after the pre-design investigation. For cost-estimating purposes, it is assumed that chemical oxidant would be injected inside the 1,000 μg/L PCE isocontour in the saprolite. This is anticipated to be a chemical or biological treatment process that would target the most contaminated areas of the saprolite aquifer. Similar to Alternative GW-3, focused *in-situ* treatment has the potential to be effective by removing higher concentrations at the center of the plume. The fringe areas of the plume would be allowed to attenuate naturally over time, a process that would be enhanced by removing the most elevated levels through treatment.

In-situ treatment has the potential to more rapidly clean up the contaminant plume but, unlike extraction and treatment (e.g., Alternatives GW-2 or GW-3), treating the center of the plume does not actively prevent further migration. If determined necessary during the remedial design phase, an additional treatment zone would be placed at the downgradient edge of the PCE plume (assumed, for cost-estimating purposes, to be at the 200 μg/L contour**)** in the saprolite. The exact location would be determined after field studies to evaluate the technical performance of *in-situ* treatment.

This additional downgradient treatment zone could take the form of either an *in-situ* remedy such as a permeable reactive barrier, or an extraction and treatment system to hydraulically control contaminant migration. The need for this downgradient treatment system would be determined during remedial design. For cost-estimating purposes, a downgradient treatment zone using *in-situ* treatment has been assumed.

In-situ treatment typically involves the addition of treatment amendments to the groundwater, followed by a period of monitoring, and then additional treatments based upon the monitoring results. A long-term monitoring program would be implemented and *in-situ* treatment would continue, as needed, until the aquifer has been restored to the extent practicable. If treatment of the downgradient portion of the plume is not deemed necessary, long-term monitoring of the saprolite and bedrock aquifers would be performed to ensure that natural degradation of contaminants is occurring at an adequate rate.

EVALUATION OF REMEDIAL ALTERNATIVES

During the detailed evaluation of remedial alternatives, each alternative is assessed against nine evaluation criteria, namely overall protection of human health and the environment, compliance with applicable or relevant and appropriate requirements, long-term effectiveness and permanence, reduction of toxicity, mobility, or volume (T/M/V) through treatment, short-term effectiveness, implementability, cost, Commonwealth acceptance, and community acceptance.

The evaluation criteria are described below.

- Overall protection of human health and the environment addresses whether or not a remedy provides adequate protection and describes how risks posed through each exposure pathway (based on a reasonable maximum exposure scenario) are eliminated, reduced, or controlled through treatment, engineering controls, or ICs.

- Compliance with ARARs addresses whether a remedy would meet all of the applicable or relevant and appropriate requirements of federal and state environmental statutes and requirements or provide grounds for invoking a waiver.

- Long-term effectiveness and permanence refers to the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup goals have been met. It also addresses the magnitude and effectiveness of the measures that may be required to manage the risk posed by treatment residuals and/or untreated wastes.

- Reduction of toxicity, mobility, or volume through treatment is the anticipated performance of the treatment technologies, with respect to these parameters, a remedy may employ.

- Short-term effectiveness addresses the period of time needed to achieve protection and any adverse impacts on human health and the environment that may be posed during the construction and implementation period until cleanup goals are achieved.

- Implementability is the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement a particular option.

- Cost includes estimated capital and O&M costs and net present-worth costs.

- Commonwealth acceptance indicates if, based on its review of the RI/FS reports and Proposed Plan, the Commonwealth concurs with the preferred remedy at the present time.

- Community acceptance would be assessed in the ROD and refers to the public's general response to the alternatives described in the Proposed Plan and the RI/FS reports.

A comparative analysis of these alternatives based upon the evaluation criteria noted above is presented below.

Soil Alternatives for IDC

Overall Protection of Human Health and the Environment

Alternative IDC-S1 (No Action) would not meet the RAOs and would not be protective of human health or the environment since no action would be taken. Contamination would remain in the soil at IDC and no mechanisms would be implemented to prevent migration of contaminants to the underlying groundwater, or to reduce the T/M/V of the contamination except through natural attenuation processes which would not be monitored to assess the effectiveness or predict the duration of this alternative.

Alternative IDC-S2 (Containment) would meet the RAOs and would be protective of human health and the environment if the cap is properly maintained. Since the cap would minimize the infiltration of rainwater, it would reduce the potential for the contaminants to migrate to the underlying groundwater. An additional component included as part of this alternative is the installation of vapor mitigation systems that would also mitigate any potential exposure to VOCs migrating from contaminated soils. However, this alternative would not provide treatment to reduce the T/M/V of the contaminants.

Alternative IDC-S3 (Soil Vapor Extraction and Containment) would provide treatment to reduce the T/M/V of the contaminants. While effective at reducing contaminant mass, some portion of the contaminants' mass is expected to remain, because SVE could have limitations to remove the contaminants from the clayey soil matrix.

A monitoring program under Alternatives IDC-S2 and IDC-S3 would ensure human health and environmental protection.

Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

There is no Federal or Puerto Rico chemical-specific ARARs for soil. All the alternatives except No Action would comply with location-specific and action-specific ARARs. Location- and action-specific ARARs do not apply to the No Action alternative since no work would be implemented.

Long-Term Effectiveness and Permanence

Under Alternative IDC-S1 (No Action), contamination would continue to be present in the vadose zone and migrate in the soil, and could potentially impact groundwater at some point in the future. Alternative IDC-S1 would not be effective or permanent over the long-term.

For Alternative IDC-S2 (Containment), the cap does not reduce the toxicity or volume of contamination. The cap would meet the direct-contact RAO over the long-term through effective monitoring and maintenance, and institutional controls.

For Alternative IDC-S3 (Soil Vapor Extraction and Containment), the soils would be treated to address VOCs. It is possible, due to technical limitations, that not all the contamination would be removed from the clayey soil. Capping in addition to SVE treatment would reduce contaminant migration from the vadose zone to the groundwater. The radius of influence of SVE wells would be low in clayey soil, and environmental fracturing, commonly used to expand the effectiveness of SVE, may not be advisable in the surface interval (less than a depth of ten feet), to avoid damaging buildings. In the areas where SVE would not be implemented, a well-maintained cap and institutional controls would achieve the direct-contact RAO over the long-term. Alternatives IDC-S2 and IDC-S3 also would provide vapor intrusion mitigation as necessary.

Reduction of Toxicity, Mobility, or Volume Through Treatment

The Alternative IDC-S1 (No Action) would not reduce contaminant T/M/V through treatment since no remedial action would be conducted.

Alternative IDC-S2 (Containment) would not reduce toxicity or volume. However, it would reduce mobility by minimizing infiltration of rainwater into the contaminated soil.

Alternative IDC-S3 (Soil Vapor Extraction and Containment) would achieve reduction of T/M/V through treatment of the hot spot, while the remainder of the soil would be capped. As described earlier, SVE treatment may not be fully effective at treating the VOCs in soil; residual soil contamination would be capped.

Short-Term Effectiveness

With respect to Alternative IDC-S1 (No Action), there would be no short-term impacts as no remedial action would occur. There could be short-term impacts to the local community and workers associated with all of the action alternatives from construction and operation activities. These impacts would be mitigated through standard health and safety practices that mitigate exposure risks. Measure would include air monitoring, engineering controls and appropriate worker personal protective equipment (PPE) during implementation of all action alternatives.

Implementability

Alternative IDC-S1 (No Action) would be easiest both technically and administratively to implement as no work would be performed at the Site. Experienced vendors would be readily available to implement capping (Alternatives IDC-S2 and IDC-S3) and SVE (which is included in Alternative IDC-S3).

For SVE, there may be some difficulty getting drill rigs into the treatment zone due to the narrow alleyway. The building toward the alleyway would need to be modified with an opening through the building wall to gain access to the treatment area.

Cost

The cost estimates for all alternatives are provided below.

IDC Soil Alternative	Capital Cost	Present Worth O&M Cost	Total Present Worth Cost
IDC-S1	$0	$0	$0
IDC-S2	$ 159,000	$ 46,000	$ 205,000
IDC-S3	$ 1,239,000	$ 556,000	$ 1,795,000

Commonwealth/Support Agency Acceptance

The PREQB agrees with the preferred remedy in this Proposed Plan.

Community Acceptance

Community acceptance of the preferred remedy will be evaluated after the public comment period ends and will be described in the Responsiveness Summary section of the ROD for this Site. The ROD is the document that formalizes the selection of the remedy for a site.

Soil Alternatives for Ramallo Property

Overall Protection of Human Health and the Environment

Alternative R-S1 (No Action) would not meet the RAOs and would not be protective of human health and the environment since no action would be taken. Contamination would remain in the soil at Ramallo, while no mechanisms would be implemented to prevent direct contact of the contaminated soils, migration of contaminants to the groundwater, or to reduce the T/M/V of contamination except through natural attenuation processes, which would not be monitored to assess the effectiveness or predict the duration of this alternative.

The protectiveness of Alternative R-S2 (Containment) relies on continuing maintenance of a cap indefinitely. A well-maintained cap would be a barrier for direct contact and rainwater infiltration.

While the cap can be expected to slow the flux of contamination from soil and into the underlying groundwater, it may not stop the flux completely; consequently, the underlying groundwater may continue to be impacted. Only monitoring over time could answer this question.

Alternative R-S3 (Soil Vapor Extraction and Thermal Treatment; Excavation, Disposal, and Backfill; and Containment) is the most likely to be protective over time because this alternative would actively remove contaminant mass from the subsurface. SVE and thermal treatment would be expected to remove most of the contaminant mass from the treatment zone (over 90 percent).

Alternative R-S4 (*In-situ* Treatment and Containment) would meet the RAOs and would be protective of human health and the environment if the cap is properly maintained. Since the cap would minimize the infiltration of rainwater, it would reduce the potential for the contaminants to migrate to the underlying groundwater. *In-situ* treatment would also mitigate potential exposure to VOCs and would provide treatment to reduce the T/M/V of the contaminants.

Alternative R-S4 would provide treatment to the hot spot. The long-term soil vapor mitigation and monitoring program in Alternatives R-S2 through R-S4 would ensure human health is protected.

Alternatives R-S2, R-S3, and R-S4 would achieve the RAO for direct contact through capping.

For each alternative, institutional controls would be utilized to further ensure overall protection.

Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

There are no Federal or Puerto Rico chemical-specific ARARs for soil. All the alternatives except No Action would comply with location-specific and action-specific ARARs. Location- and action-specific ARARs do not apply to the No Action alternative since no work would be implemented.

Long-Term Effectiveness and Permanence

Under Alternative R-S1 (No Action), contamination would continue to flux from the soil into groundwater and be present at the unpaved ground surface where it could impact biota and humans. No Action would not be effective or permanent over the long-term.

The capping alternative would not reduce toxicity or volume, but would be designed to reduce mobility by minimizing infiltration of rainwater into the contaminated soil. A cap does have the potential to effectively meet RAOs over the long-term; however, the cap would have to be well-maintained indefinitely. The active remedial alternatives, R-S3 and R-S4, are more permanent and effective over the long-term than R-S2 because they remove or destroy some contamination in the subsurface, thus decreasing T/M/V. Alternatives R-S2 through R-S4 would provide vapor intrusion mitigation as necessary.

Thermal remediation is expected to heat the entire volume of the treatment zone, and thus would be the most effective alternative for removing the contaminant mass. Amendments introduced by environmental hydraulic fracturing under R-S4 would diffuse into the clay to attack the existing diffused contaminants. However, introduction via discrete fractures cannot be expected to uniformly distribute amendments throughout the treatment zone, and there would likely be some gaps in treatment. As a result, not all of the contaminant mass would be removed from the clayey soil. A well-maintained cap and institutional controls for Alternatives R-S2, R-S3, and R-S4 would be critical to the ability to meet RAOs over the long-term.

Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternative R-S1would not reduce contaminant T/M/V since no remedial action would be conducted.

The R-S2 alternative would not reduce toxicity or volume, but would be designed to reduce mobility by minimizing infiltration of rainwater into the contaminated soil. R-S3 and R-S4 would reduce T/M/V through treatment, with R-S3 providing more treatment than R-S4. SVE would remove the contamination from the subsurface, and *in-situ* chemical treatment would destroy the contamination in situ. The extent and effectiveness of T/M/V reduction would need to be verified with monitoring for both R-S3 and R-S4.

Short-Term Effectiveness

With respect to the No Action alternative, there would be no short-term impact to the community and environment as no remedial action would occur. There would be short-term impacts to the local community and workers for the remaining alternatives due to the active remedial actions undertaken and associated construction, operation, and/or injection activities. Alternative R-S3 would have the highest impact since operations would last the longest, followed by R-S4, then R-S2. Air monitoring, engineering controls and appropriate worker PPE would be used to protect the community and workers for Alternatives R-S2 through R-S4.

Implementability

Alternative R-S1 would be the easiest both technically and administratively to implement as no work would be performed at the Site. Alternatives R-S2, R-S3, and R-S4 would be constructible and operable since services, materials, and experienced vendors would be readily available. Maintenance and inspection would be needed indefinitely for the capping alternative; it is difficult to predict if these activities would be performed as regularly as needed in the future.

Cost

The cost estimates for all four alternatives are provided below.

Ramallo Soil Alternative	Capital Costs	Present Worth O&M Costs	Total Present Worth
R-S1	$0	$0	$0
R-S2	$ 299,000	$ 70,000	$ 369,000
R-S3	$ 3,664,000	$ 70,000	$ 3,734,000
R-S4	$ 1,785,000	$ 70,000	$ 1,855,000

Commonwealth/Support Agency Acceptance

The PREQB agrees with the preferred remedy in this Proposed Plan.

Community Acceptance

Community acceptance of the preferred remedy will be evaluated after the public comment period ends and will be described in the Responsiveness Summary section of the ROD for this Site.

Groundwater Remedial Alternatives

Overall Protection of Human Health and the Environment

Alternative GW-1 (No Action) would not meet the RAOs and would not be protective of human health and the environment since no action would be taken. No mechanisms would be implemented to reduce the T/M/V of the contamination except through natural processes which would not be monitored to assess the effectiveness or predict the duration of this alternative.

Alternatives GW-2 (Groundwater Extraction, Treatment, and Long-term Monitoring), GW-3 (Focused Groundwater Extraction, Treatment, and Long-term Monitoring), and GW-4 (*In-situ* Treatment and Long-term Monitoring) would be effective when combined with institutional controls to prevent future human exposure to groundwater contamination. These alternatives also provide protection over time because they employ active remediation to either reduce the toxicity, mobility, or volume of contamination. These alternatives would achieve the RAOs.

The effectiveness of these alternatives would be assessed through routine groundwater monitoring and five-year reviews. Alternatives GW-2 and GW-3 would be equally effective, followed by Alternative GW-4.

Compliance with ARARs

All the alternatives except No Action are anticipated to satisfy the chemical-specific ARARs by achieving the remediation goals in the future and would comply with location-specific and action-specific ARARs.

Long-Term Effectiveness and Permanence

Alternative GW-1 (No Action) would not be effective over the long-term since no action would be implemented to reduce the level of contamination or to restore the aquifer. Alternatives GW-2 (Groundwater Extraction, Treatment, and Long-term Monitoring), GW-3 (Focused Groundwater Extraction, Treatment, and Long-term Monitoring), and GW-4 (*In-situ* Treatment and Long-term Monitoring) would be effective since they combine treatment, long-term monitoring and institutional controls. Alternatives GW-2 and GW-3 rely on extraction and treatment which, while controlling further plume migration and removing contaminants for *ex-situ* treatment, have an uncertain potential to restore the groundwater in this type of aquifer. The current time estimate for reaching MCLs for either GW-2 or GW-3 is 30 years; the actual time required would be better estimated after a number of years of operation. Based upon EPA's experience at similar sites, the time frame may be much longer than 30 years.

GW-4 would employ focused treatment to destroy the contaminants. It is currently estimated that the treatment zone would be effectively treated in approximately 10 years.

All the active groundwater remedies would require ICs to prevent exposure until the RAOs can be achieved through treatment. The effectiveness of these alternatives would be assessed through routine groundwater monitoring and five-year reviews.

Reduction of Toxicity, Mobility, or Volume through Treatment

The No Action alternative would not reduce contaminant T/M/V since no remedial action would be conducted.

Alternatives GW-2, GW-3, and GW-4 would reduce T/M/V through treatment. GW-2 and GW-3 would remove contaminated groundwater and treat it *ex situ,* while GW-4 would chemically treat and destroy contamination *in situ*. The extent and effectiveness of T/M/V reduction would need to be verified with monitoring results. It is expected that Alternatives GW-2, GW-3 and GW-4 would result in similar T/M/V reduction, but that GW-4 may achieve reduction in a shorter time frame.

Short-Term Effectiveness

With respect to the No Action alternative, there would be no short-term impact to the community, environment, and the workers, as no remedial action would occur. There would be short-term impacts to the local community and workers for the remaining alternatives due to the active remedial actions undertaken and associated construction, operation, extraction and/or injection activities. Air monitoring, engineering controls and appropriate worker PPE would be used to protect the community and workers for Alternatives GW-2, GW-3, and GW-4. Alternative GW-4 would have the highest degree of impact, followed by Alternatives GW-2 and GW-3. The time frame for implementation of GW-4 (10 years) is substantially shorter than the period for GW-2 or GW-3 (30 years).

Implementability

The No Action alternative would be easiest both technically and administratively to implement as no additional work would be performed at the Site.

Alternatives GW-2, GW-3, and GW-4 would be constructible and operable since services, materials, and experienced vendors would be readily available. Alternatives GW-2 and GW-3 would require space for the treatment plant and the interconnecting piping between the extraction wells, the treatment plant and the discharge point. Alternative GW-4 would require access to a large area for injection treatment. Access and space limitations around the Ramallo facility and Cidra Industrial Park could make it difficult to implement Alternative GW-4. Institutional controls such as deed restrictions would also need to be implemented for Alternatives GW-2, GW-3 and GW-4.

Cost

The cost estimates for all four alternatives are provided below.

Groundwater Alternative	Capital Costs	Present Worth O&M Costs	Total Present Worth
GW-1	$0	$0	$0
GW-2	$ 3,032,000	$ 6,389,000	$ 9,421,000
GW-3	$ 2,715,000	$ 6,166,000	$ 8,881,000
GW-4	$ 4,828,000	$ 2,547,000	$ 7,375,000

Commonwealth/Support Agency Acceptance

The PREQB agrees with the preferred remedy in this Proposed Plan.

Community Acceptance

Community acceptance of the preferred remedy will be evaluated after the public comment period ends and will be described in the Responsiveness Summary section of the ROD for this Site.

PREFERRED REMEDY

Soil at IDC

Alternative IDC-S3 (Soil Vapor Extraction and Containment) is the preferred alternative for IDC. Under this alternative, the hot spot would be targeted with soil vapor extraction, and capping would be implemented to provide direct-contact protection. For cost estimating purposes, it is assumed that the hotspot in the alleyway would be treated with SVE, approximately 100 square feet and 20 feet deep. The actual extent of the principal threat wastes to be targeted with SVE would be determined during a pre-design investigation.

Since the Site soils are low-permeability clay, air flow through the soil is expected to be low and treatment with SVE is likely to require closely spaced wells. The compressor for the system and a vapor treatment system would be installed in the IDC building. It is anticipated that the system would run for up to 10 years. Capping would still need to be relied upon to meet RAOs over the long-term.

Soil at the Ramallo Property

Alternative R-S3 (SVE with Thermal Treatment; Excavation, Disposal, and Backfill; and Containment) is the preferred alternative for the contaminated soil at the Ramallo property.

Under this alternative, soil vapor extraction would be enhanced by thermal heating of the treatment zone. A hollow stem auger would be used inside and outside the building to advance combined SVE wells and heating electrodes to the bottom of the treatment zone on approximately 20-foot centers. The electrical equipment, compressor for the system and the vapor and condensate treatment system would be located on the Ramallo property.

In addition to SVE, elevated PCE concentrations that exceed the principal threat waste criterion (concentrations exceeding the soil saturation limit for PCE of 166 mg/kg, indicating the potential presence of DNAPL) were detected at the surface. Surface soil contamination would be excavated and disposed off-site in a permitted disposal facility. A cap would then be installed over the remediation target zone to minimize infiltration of rainwater into the contaminated soil. The cap would need to be inspected and maintained.

An additional component included as part of the IDC and Ramallo preferred remedies is the installation of vapor mitigation systems. As described in the Remedial Action Objectives section of this Proposed Plan, the indoor spaces are not currently occupied, and vapor mitigation systems would be considered upon occupancy. For cost-estimating purposes, it is assumed that two SVE systems would be installed as part of this alternative. Following installation, these systems would need to be monitored to ensure their performance.

Groundwater

Alternative GW-4 – *In-situ* Treatment and Long-term Monitoring is the preferred alternative for the Ramallo groundwater plume. The preferred remedy would also monitor groundwater conditions at IDC, but no other response action is required. In the saprolite aquifer, *in-situ* treatment would be implemented under this alternative within a focused isocontour, and potentially in the downgradient portion of the plume as determined by the pre-design investigation. Long-term groundwater monitoring of contaminants in the saprolite and bedrock aquifers would be performed to assess remedial action performance.

For cost-estimating purposes, it is assumed that a chemical oxidant would be injected inside the 1,000 µg/L PCE isocontour in the saprolite. This is anticipated to be a chemical or biological treatment process that would target the most contaminated areas of the saprolite aquifer. If necessary, based on groundwater modeling results during the remedial design phase, a treatment zone such as a permeable reactive barrier or extraction well system, would be placed at the downgradient edge of the PCE plume (200 µg/L contour) in the saprolite. The exact location would be determined after a treatability and/or pilot study, which would evaluate the technical performance of a barrier.

In-situ treatment also requires access to the land surface above the plume and, in several areas, access will be difficult. During remedial design, extraction and treatment may be evaluated for some of these limited access areas of the plume, to determine if it would enhance the overall performance of the remedy.

The preferred Alternative GW-4 as described in this Proposed Plan blends aspects of Alternative GW-3 (focused extraction/treatment) into GW-4. The FS report assessed Alternative GW-3 and Alternative GW-4 separately. The FS report developed separate order-of-magnitude engineering cost estimates for these alternatives. These cost estimates are meant to provide EPA and the public with a method of comparing the relative costs for different remedial alternatives. With regard to cost, EPA expects that, to the degree that extraction and treatment is employed in the preferred groundwater remedy, it would be in place of (rather than in addition to) some portion of the *in-situ* treatment, and that the FS cost estimate for Alternative GW-4 is representative of the preferred alternative cost.

BASIS FOR REMEDY PREFERENCE

The Preferred Alternatives are believed to provide the best balance of tradeoffs among the alternatives based on the information available to EPA at this time. EPA and PREQB believe that the preferred remedy would treat principal threats, be protective of human health and the environment, comply with ARARs, be cost-effective and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. The preferred remedy also would meet the statutory preference for the use of treatment as a principal element. The preferred alternative can change in response to public comment or new information.

The environmental benefits of the preferred remedy may be enhanced by consideration, during the design, of technologies and practices that are sustainable in accordance with EPA Region 2's Clean and Green Energy Policy. This would include consideration of green remediation technologies and practices.

GLOSSARY

ARARs: Applicable or Relevant and Appropriate Requirements. These are Federal or more stringent State environmental rules and regulations that may pertain to the site or a particular alternative.

Carcinogenic Risk: Cancer risks are expressed as a number reflecting the increased chance that a person will develop cancer if exposed to chemicals or substances. For example, EPA's acceptable risk range for Superfund hazardous waste sites is 1×10^{-4} to 1×10^{-6}, meaning there is 1 additional chance in 10,000 (1×10^{-4}) to 1 additional chance in 1 million (1×10^{-6}) that a person will develop cancer if exposed to a site contaminant that is not remediated.

CERCLA: Comprehensive Environmental Response, Compensation and Liability Act. A Federal law, commonly referred to as the "Superfund" Program, passed in 1980 that provides for response actions at sites found to be contaminated with hazardous substances, pollutants or contaminants that endanger public health and safety or the environment.

CERCLIS: Comprehensive Environmental Response Compensation and Liability Information System

COPC: Chemical of Potential Concern.

SLERA: Screening Level Ecological Risk Assessment. An evaluation of the potential risk posed to the environment if remedial activities are not performed at the site.

FS: Feasibility Study. Analysis of the practicability of multiple remedial action options for the site.

Groundwater: Subsurface water that occurs in soils and geologic formations that are fully saturated.

HHRA: Human Health Risk Assessment. An evaluation of the risk posed to human health should remedial activities not be implemented.

HI: Hazard Index. A number indicative of non-carcinogenic health effects that is the ratio of the existing level of exposure to an acceptable level of exposure. A value equal to or less than one indicates that the human population is not likely to experience adverse effects.

HQ: Hazard Quotient. HQs are used to evaluate non-carcinogenic health effects and ecological risks. A value equal to or less than one indicates that the human or ecological population is not likely to experience adverse effects.

ICs: Institutional Controls. Administrative methods to prevent human exposure to contaminants, such as by restricting the use of groundwater for drinking water purposes.

MCLs: Maximum Contaminant Levels. Standards that are set by the EPA for drinking water quality. An MCL is the legal threshold limit on the amount of a substance that is allowed in public water systems under the Safe Drinking Water Act. The limit is usually expressed as a concentration in milligrams or micrograms per liter of water.

Nine Evaluation Criteria: See the "Evaluation of Remedial Alternatives" section of the Proposed Plan.

Non-carcinogenic Risk: Non-cancer Hazards (or risk) are expressed as a quotient that compares the existing level of exposure to the acceptable level of exposure. There is a level of exposure (the reference dose) below which it is unlikely for even a sensitive population to experience adverse health effects. EPA's threshold level for non-carcinogenic risk at Superfund sites is 1.0, meaning that if the exposure exceeds the threshold; there may be a concern for potential non-cancer effects.

NPL: National Priorities List. A list developed by EPA of uncontrolled hazardous substance release sites in the United States that are considered priorities for long-term remedial evaluation and response.

Practical Quantitation Level (PQL): means the lowest concentration of a constituent that can be reliably achieved among laboratories within specified limits of precision and accuracy during routine laboratory operating conditions.

Present-Worth Cost: Total cost, in current dollars, of the remedial action. The present-worth cost includes capital costs required to implement the remedial action, as well as the cost of long-term operation, maintenance, and monitoring.

PRPs: Potentially Responsible Parties.

Proposed Plan: A document that presents the preferred remedial alternative and requests public input regarding the proposed cleanup alternative.

Public Comment Period: The time allowed for the members of a potentially affected community to express views and concerns regarding EPA's preferred remedial alternative.

RAOs: Remedial Action Objectives. Objectives of remedial actions that are developed based on contaminated media, contaminants of concern, potential receptors and exposure scenarios, human health and ecological risk assessment, and attainment of regulatory cleanup levels.

Record of Decision (ROD): The legal document that describes the cleanup action or remedy selected for a site, the basis for choosing that remedy, and public comments on the selected remedy.

Remedial Action: A cleanup to address hazardous substances at a site.

RI: Remedial Investigation. A study of a facility that supports the selection of a remedy where hazardous substances have been disposed or released. The RI identifies the nature and extent of contamination at the facility and analyzes risk associated with COPCs.

Saturated Soils: Soils that are found below the water table. These soils stay wet.

Standard Quantitation Limit: The quantity of a substance that can be reasonably quantified given the limits of detection for the methods of analysis and sample characteristics that may affect quantitation (e.g., dilution, concentration).

TBCs: "To-be-considered" criteria consist of non-promulgated advisories and/or guidance that were developed by EPA, other federal agencies, or states that may be useful in developing CERCLA remedies.

EPA: The United States Environmental Protection Agency, the federal agency responsible for administration and enforcement of CERCLA (and other environmental statutes and regulations), and selection and issuance of the ROD.

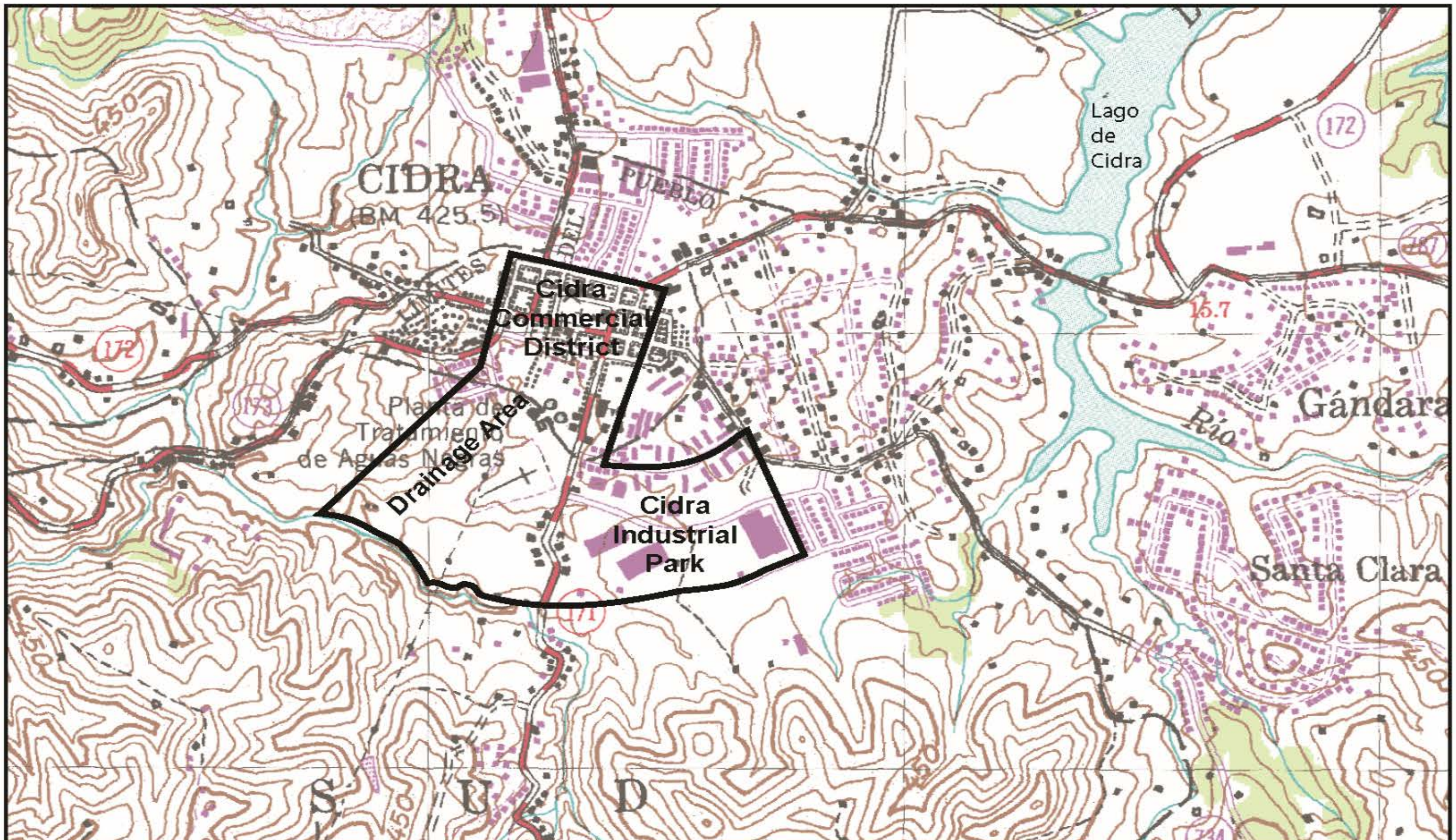
VOC: Volatile Organic Compound. Type of chemical that readily vaporizes, often producing a distinguishable odor.

Water Table: The water table is an imaginary line marking the top of the water-saturated area within a rock column.

Table 1 Remediation Goals for Soil (all concentrations in µg/kg)				
Contaminants of Concern	**Soil Protective of Groundwater**	**Human Health Risk**	**Remediation Goals**	**Maximum Detected Concentrations**
cis-1,2-Dichloroethene	139	-	139	41,000
Tetrachloroethene	24	107,000	24	3,300,000
Trichloroethene	15	-	15	2,700
Vinyl chloride	0.3	-	0.3	2,000

Table 2 Screening Criteria for Vapor Intrusion		
Contaminants of Concern	**Screening Level**	**Maximum Detected Concentrations**
	µg/m³	**µg/m³**
Volatile Organic Compounds		
Residential Screening Levels		
Subslab		
cis-1,2-Dichloroethene	N/A	89
Tetrachloroethene	94	9,400
Trichloroethene	4.3	520
Vinyl chloride	1.6	ND
Indoor Air		
cis-1,2-Dichloroethene	N/A	0
Tetrachloroethene	9.4	4.8
Trichloroethene	0.43	0.22
Vinyl chloride	0.16	ND
Commercial/Industrial Screening Levels		
Subslab		
cis-1,2-Dichloroethene	N/A	ND
Tetrachloroethene	472	2,200,000
Trichloroethene	30	4
Vinyl chloride	28	ND
Indoor Air		
cis-1,2-Dichloroethene	N/A	0.16
Tetrachloroethene	47	31
Trichloroethene	3.0	0.69
Vinyl chloride	2.79	ND
Ambient Air		
cis-1,2-Dichloroethene	N/A	ND
Tetrachloroethene	9.4	ND
Trichloroethene	0.43	0.62
Vinyl chloride	0.16	ND

Table 3 **Remediation Goals for Groundwater (all concentrations in µg/L)**			
Contaminants of Concern	**National Primary Drinking Water Standards (EPA MCLs)**	**Remediation Goals**	**Maximum Detected Concentrations**
cis-1,2-Dichloroethene	70	70	74
Tetrachloroethene	5	5	1,700
Trichloroethene	5	5	31
Vinyl chloride	2	2	0.17



Source USGS 7.5 Minute Series Topographic Map, Comerio Quadrangle, Puerto Rico

Site Area

N

approximate scale

0 0.25 0.5 miles

Figure 1
Site Location Map
Cidra Groundwater Contamination Site
Cidra, Puerto Rico

CDM Smith

R2-0009085

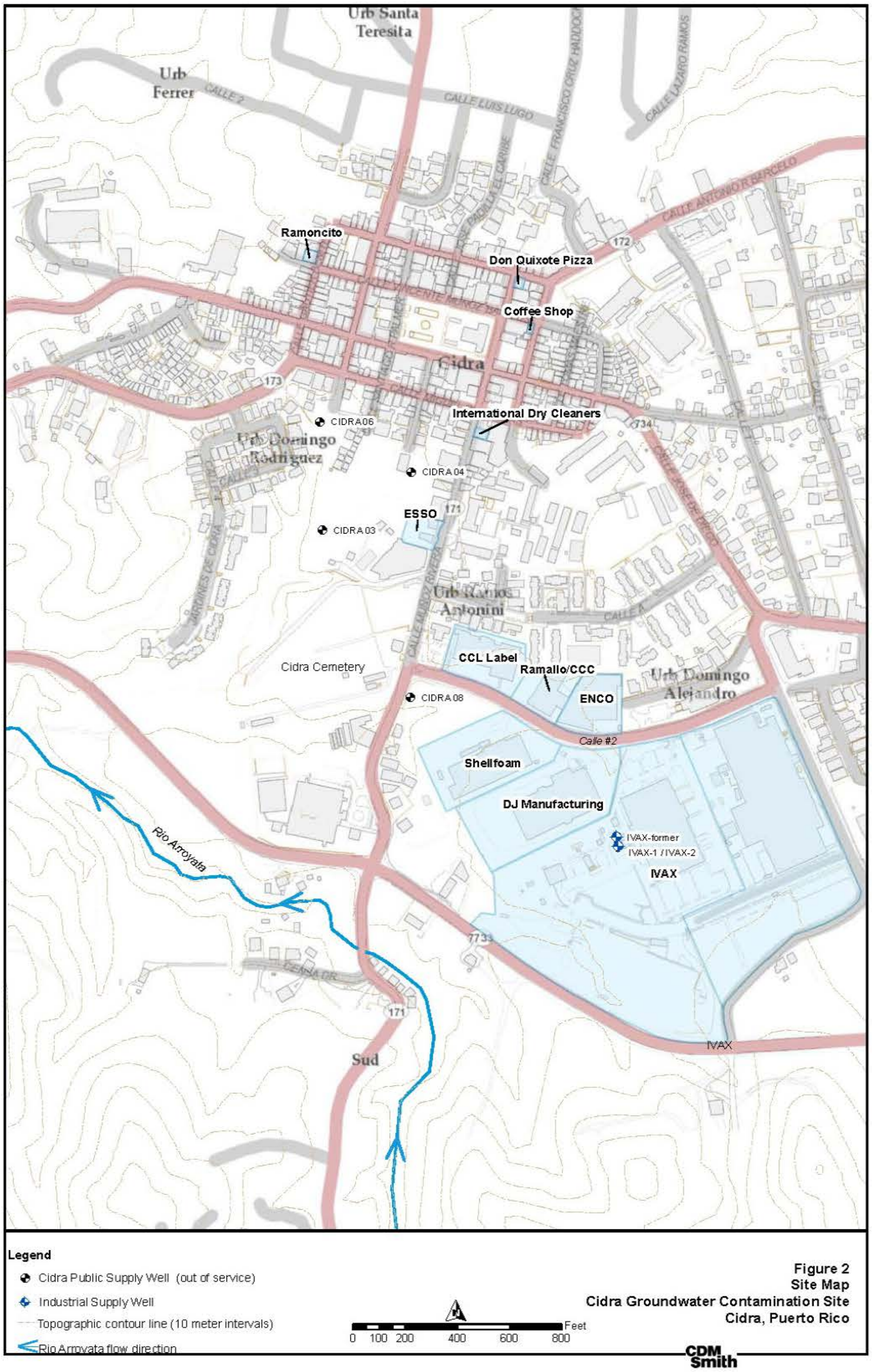
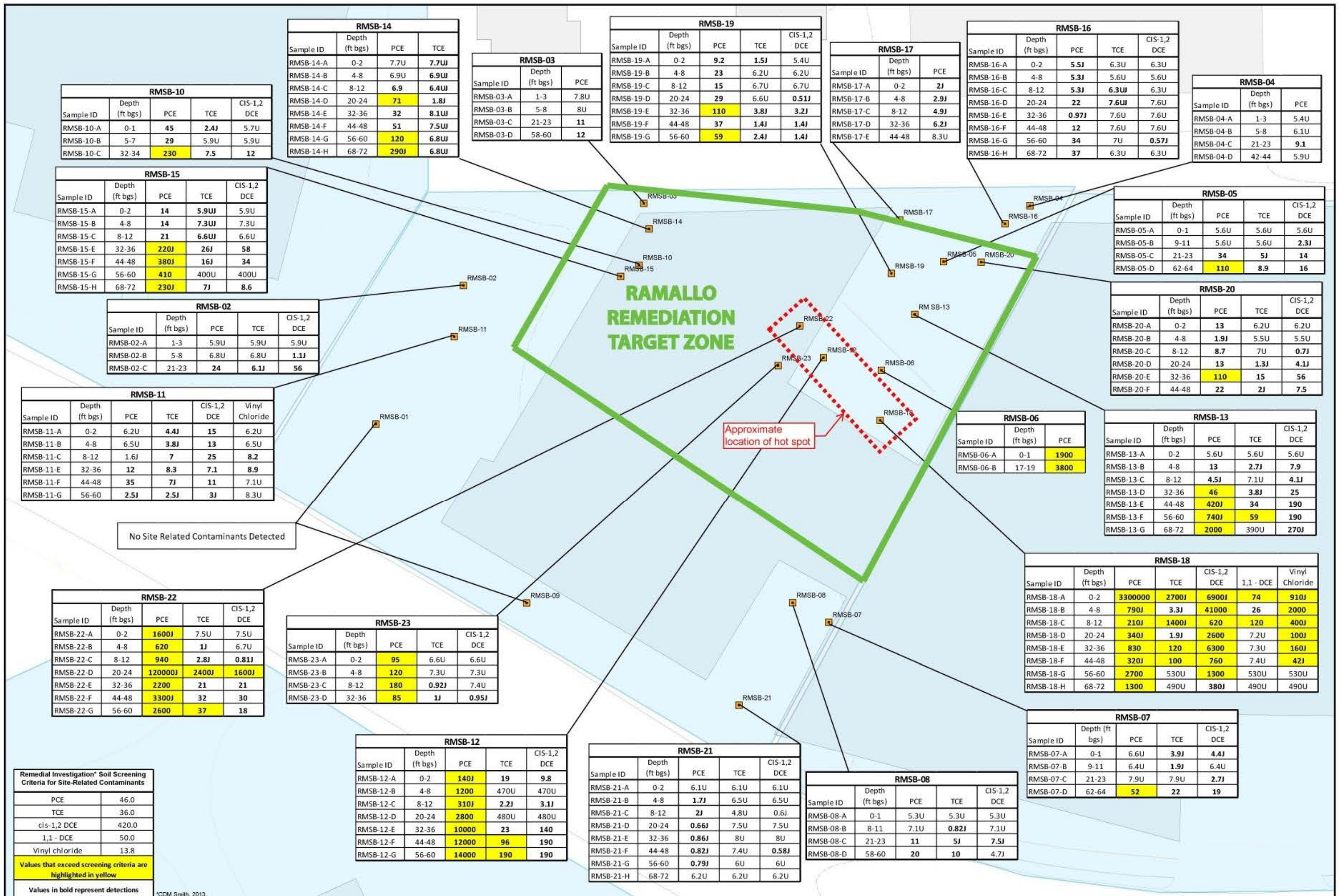


Figure 2
Site Map
Cidra Groundwater Contamination Site
Cidra, Puerto Rico

R2-0009086



RMSB-14

Sample ID	Depth (ft bgs)	PCE	TCE
RMSB-14-A	0-2	7.7U	**7.7UJ**
RMSB-14-B	4-8	6.9U	**6.9UJ**
RMSB-14-C	8-12	**6.9**	**6.4UJ**
RMSB-14-D	20-24	**71**	**1.8J**
RMSB-14-E	32-36	**32**	**8.1UJ**
RMSB-14-F	44-48	**51**	**7.5UJ**
RMSB-14-G	56-60	**120**	**6.8UJ**
RMSB-14-H	68-72	**290J**	**6.8UJ**

RMSB-03

Sample ID	Depth (ft bgs)	PCE
RMSB-03-A	1-3	7.8U
RMSB-03-B	5-8	8U
RMSB-03-C	21-23	**11**
RMSB-03-D	58-60	**12**

RMSB-19

Sample ID	Depth (ft bgs)	PCE	TCE	CIS-1,2 DCE
RMSB-19-A	0-2	**9.2**	**1.5J**	5.4U
RMSB-19-B	4-8	**23**	6.2U	6.2U
RMSB-19-C	8-12	**15**	6.7U	6.7U
RMSB-19-D	20-24	**29**	6.6U	**0.51J**
RMSB-19-E	32-36	**110**	**3.8J**	**3.2J**
RMSB-19-F	44-48	**37**	**1.4J**	**1.4J**
RMSB-19-G	56-60	**59**	**2.4J**	**1.4J**

RMSB-17

Sample ID	Depth (ft bgs)	PCE
RMSB-17-A	0-2	**2J**
RMSB-17-B	4-8	**2.9J**
RMSB-17-C	8-12	**4.9J**
RMSB-17-D	32-36	**6.2J**
RMSB-17-E	44-48	8.3U

RMSB-16

Sample ID	Depth (ft bgs)	PCE	TCE	CIS-1,2 DCE
RMSB-16-A	0-2	**5.5J**	6.3U	6.3U
RMSB-16-B	4-8	**5.3J**	5.6U	5.6U
RMSB-16-C	8-12	**5.3J**	**6.3UJ**	6.3U
RMSB-16-D	20-24	**22**	**7.6UJ**	7.6U
RMSB-16-E	32-36	**0.97J**	7.6U	7.6U
RMSB-16-F	44-48	**12**	7.6U	7.6U
RMSB-16-G	56-60	**34**	7U	**0.57J**
RMSB-16-H	68-72	**37**	6.3U	6.3U

RMSB-04

Sample ID	Depth (ft bgs)	PCE
RMSB-04-A	1-3	5.4U
RMSB-04-B	5-8	6.1U
RMSB-04-C	21-23	**9.1**
RMSB-04-D	42-44	5.9U

RMSB-10

Sample ID	Depth (ft bgs)	PCE	TCE	CIS-1,2 DCE
RMSB-10-A	0-1	**45**	**2.4J**	5.7U
RMSB-10-B	5-7	**29**	5.9U	5.9U
RMSB-10-C	32-34	**230**	**7.5**	**12**

RMSB-15

Sample ID	Depth (ft bgs)	PCE	TCE	CIS-1,2 DCE
RMSB-15-A	0-2	**14**	**5.9UJ**	5.9U
RMSB-15-B	4-8	**14**	**7.3UJ**	7.3U
RMSB-15-C	8-12	**21**	**6.6UJ**	6.6U
RMSB-15-E	32-36	**220J**	**26J**	**58**
RMSB-15-F	44-48	**380J**	**16J**	**34**
RMSB-15-G	56-60	**410**	400U	400U
RMSB-15-H	68-72	**230J**	**7J**	**8.6**

RMSB-05

Sample ID	Depth (ft bgs)	PCE	TCE	CIS-1,2 DCE
RMSB-05-A	0-1	5.6U	5.6U	5.6U
RMSB-05-B	9-11	5.6U	5.6U	**2.3J**
RMSB-05-C	21-23	**34**	**5J**	**14**
RMSB-05-D	62-64	**110**	**8.9**	**16**

RMSB-02

Sample ID	Depth (ft bgs)	PCE	TCE	CIS-1,2 DCE
RMSB-02-A	1-3	5.9U	5.9U	5.9U
RMSB-02-B	5-8	6.8U	6.8U	**1.1J**
RMSB-02-C	21-23	**24**	**6.1J**	**56**

RMSB-20

Sample ID	Depth (ft bgs)	PCE	TCE	CIS-1,2 DCE
RMSB-20-A	0-2	**13**	6.2U	6.2U
RMSB-20-B	4-8	**1.9J**	5.5U	5.5U
RMSB-20-C	8-12	**8.7**	7U	**0.7J**
RMSB-20-D	20-24	**13**	**1.3J**	**4.1J**
RMSB-20-E	32-36	**110**	**15**	**56**
RMSB-20-F	44-48	**22**	**2J**	**7.5**

RMSB-11

Sample ID	Depth (ft bgs)	PCE	TCE	CIS-1,2 DCE	Vinyl Chloride
RMSB-11-A	0-2	6.2U	**4.4J**	**15**	6.2U
RMSB-11-B	4-8	6.5U	**3.8J**	**13**	6.5U
RMSB-11-C	8-12	1.6J	**7**	**25**	**8.2**
RMSB-11-E	32-36	**12**	**8.3**	**7.1**	**8.9**
RMSB-11-F	44-48	**35**	**7J**	**11**	7.1U
RMSB-11-G	56-60	**2.5J**	**2.5J**	**3J**	8.3U

RMSB-06

Sample ID	Depth (ft bgs)	PCE
RMSB-06-A	0-1	**1900**
RMSB-06-B	17-19	**3800**

RMSB-13

Sample ID	Depth (ft bgs)	PCE	TCE	CIS-1,2 DCE
RMSB-13-A	0-2	5.6U	5.6U	5.6U
RMSB-13-B	4-8	**13**	**2.7J**	**7.9**
RMSB-13-C	8-12	**4.5J**	7.1U	**4.1J**
RMSB-13-D	32-36	**46**	**3.8J**	**25**
RMSB-13-E	44-48	**420J**	**34**	**190**
RMSB-13-F	56-60	**740J**	**59**	**190**
RMSB-13-G	68-72	**2000**	390U	**270J**

RMSB-18

Sample ID	Depth (ft bgs)	PCE	TCE	CIS-1,2 DCE	1,1 - DCE	Vinyl Chloride
RMSB-18-A	0-2	**3300000**	**2700J**	**6900J**	**74**	**910J**
RMSB-18-B	4-8	**790J**	**3.3J**	**41000**	**26**	**2000**
RMSB-18-C	8-12	**210J**	**1400J**	**620**	**120**	**400J**
RMSB-18-D	20-24	**340J**	**1.9J**	**2600**	7.2U	**100J**
RMSB-18-E	32-36	**830**	**120**	**6300**	7.3U	**160J**
RMSB-18-F	44-48	**320J**	**100**	**760**	7.4U	**42J**
RMSB-18-G	56-60	**2700**	530U	**1300**	530U	530U
RMSB-18-H	68-72	**1300**	490U	**380J**	490U	490U

RMSB-22

Sample ID	Depth (ft bgs)	PCE	TCE	CIS-1,2 DCE
RMSB-22-A	0-2	**1600J**	7.5U	7.5U
RMSB-22-B	4-8	**620**	**1J**	6.7U
RMSB-22-C	8-12	**940**	**2.8J**	**0.81J**
RMSB-22-D	20-24	**120000J**	**2400J**	**1600J**
RMSB-22-E	32-36	**2200**	**21**	**21**
RMSB-22-F	44-48	**3300J**	**32**	**30**
RMSB-22-G	56-60	**2600**	**37**	**18**

RMSB-23

Sample ID	Depth (ft bgs)	PCE	TCE	CIS-1,2 DCE
RMSB-23-A	0-2	**95**	6.6U	6.6U
RMSB-23-B	4-8	**120**	7.3U	7.3U
RMSB-23-C	8-12	**180**	**0.92J**	7.4U
RMSB-23-D	32-36	**85**	**1J**	**0.95J**

RMSB-07

Sample ID	Depth (ft bgs)	PCE	TCE	CIS-1,2 DCE
RMSB-07-A	0-1	6.6U	**3.9J**	**4.4J**
RMSB-07-B	9-11	6.4U	**1.9J**	6.4U
RMSB-07-C	21-23	7.9U	7.9U	**2.7J**
RMSB-07-D	62-64	**52**	**22**	**19**

RMSB-12

Sample ID	Depth (ft bgs)	PCE	TCE	CIS-1,2 DCE
RMSB-12-A	0-2	**140J**	**19**	**9.8**
RMSB-12-B	4-8	**1200**	470U	470U
RMSB-12-C	8-12	**310J**	**2.2J**	**3.1J**
RMSB-12-D	20-24	**2800**	480U	480U
RMSB-12-E	32-36	**10000**	**23**	**140**
RMSB-12-F	44-48	**12000**	**96**	**190**
RMSB-12-G	56-60	**14000**	**190**	**190**

RMSB-21

Sample ID	Depth (ft bgs)	PCE	TCE	CIS-1,2 DCE
RMSB-21-A	0-2	6.1U	6.1U	6.1U
RMSB-21-B	4-8	**1.7J**	6.5U	6.5U
RMSB-21-C	8-12	**2J**	4.8U	0.6J
RMSB-21-D	20-24	**0.66J**	7.5U	7.5U
RMSB-21-E	32-36	**0.86J**	8U	8U
RMSB-21-F	44-48	**0.82J**	7.4U	**0.58J**
RMSB-21-G	56-60	**0.79J**	6U	6U
RMSB-21-H	68-72	6.2U	6.2U	6.2U

RMSB-08

Sample ID	Depth (ft bgs)	PCE	TCE	CIS-1,2 DCE
RMSB-08-A	0-1	5.3U	5.3U	5.3U
RMSB-08-B	8-11	7.1U	**0.82J**	7.1U
RMSB-08-C	21-23	**11**	**5J**	**7.5J**
RMSB-08-D	58-60	**20**	**10**	4.7J

Remedial Investigation* Soil Screening Criteria for Site-Related Contaminants	
PCE	46.0
TCE	36.0
cis-1,2 DCE	420.0
1,1 - DCE	50.0
Vinyl chloride	13.8
Values that exceed screening criteria are highlighted in yellow	
Values in bold represent detections	

*CDM Smith. 2013.

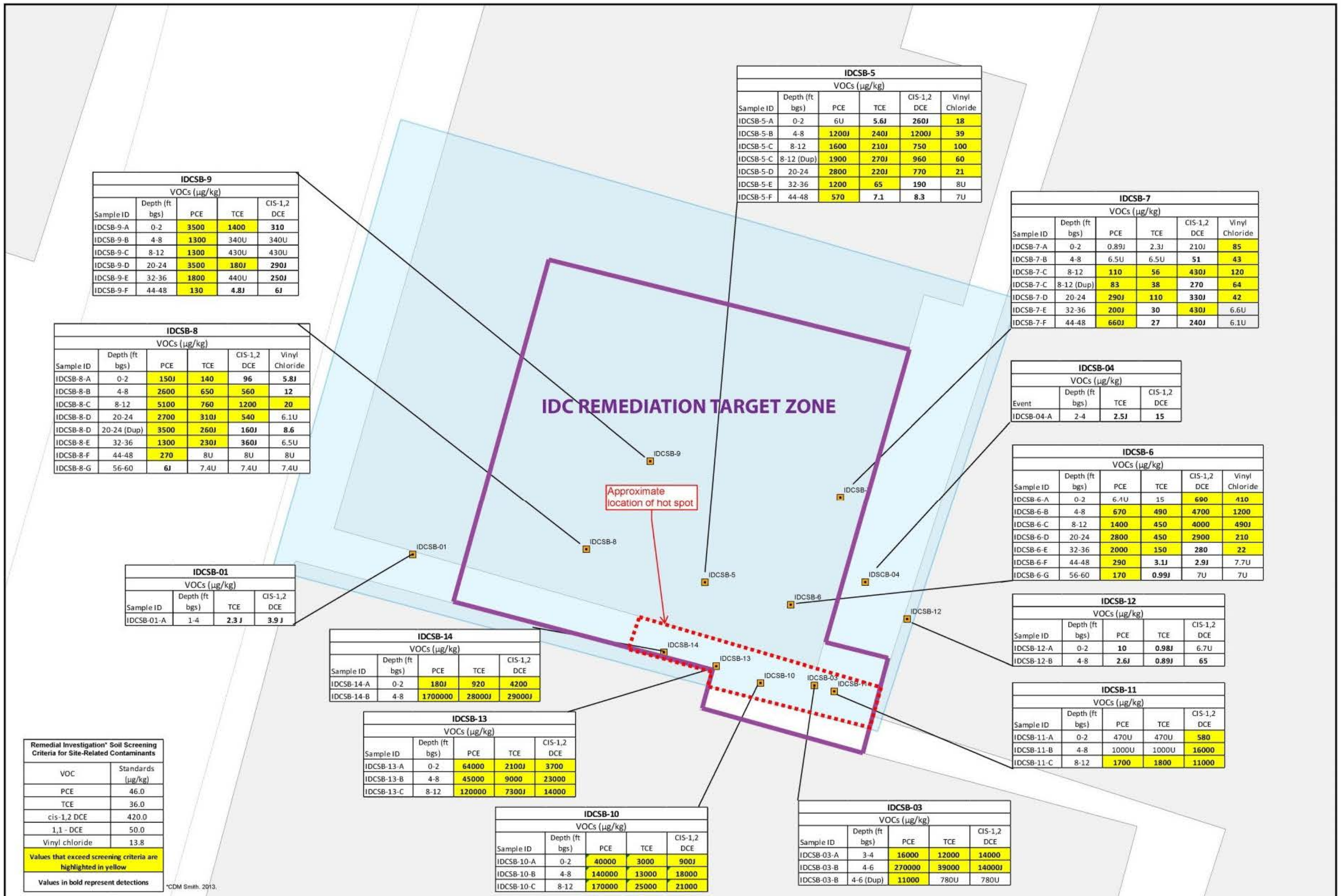
Notes:
All results in micrograms per kilogram (µg/kg)
ft bgs - feet below ground surface
J - estimated value
U - not detected above the listed detection limit

PCE - tetrachloroethene
TCE - trichloroethene
DCE - dichloroethene

0 15 30 60 90 120 Feet

Figure 3
Ramallo Remediation Target Zone
Cidra Groundwater Contamination Site
Cidra, Puerto Rico

CDM Smith



IDCSB-9				
VOCs (µg/kg)				
Sample ID	Depth (ft bgs)	PCE	TCE	CIS-1,2 DCE
IDCSB-9-A	0-2	**3500**	**1400**	**310**
IDCSB-9-B	4-8	**1300**	340U	340U
IDCSB-9-C	8-12	**1300**	430U	430U
IDCSB-9-D	20-24	**3500**	**180J**	**290J**
IDCSB-9-E	32-36	**1800**	440U	**250J**
IDCSB-9-F	44-48	**130**	**4.8J**	**6J**

IDCSB-8					
VOCs (µg/kg)					
Sample ID	Depth (ft bgs)	PCE	TCE	CIS-1,2 DCE	Vinyl Chloride
IDCSB-8-A	0-2	**150J**	**140**	**96**	**5.8J**
IDCSB-8-B	4-8	**2600**	**650**	**560**	**12**
IDCSB-8-C	8-12	**5100**	**760**	**1200**	**20**
IDCSB-8-D	20-24	**2700**	**310J**	**540**	6.1U
IDCSB-8-D	20-24 (Dup)	**3500**	**260J**	**160J**	**8.6**
IDCSB-8-E	32-36	**1300**	**230J**	**360J**	6.5U
IDCSB-8-F	44-48	**270**	8U	8U	8U
IDCSB-8-G	56-60	**6J**	7.4U	7.4U	7.4U

IDCSB-5					
VOCs (µg/kg)					
Sample ID	Depth (ft bgs)	PCE	TCE	CIS-1,2 DCE	Vinyl Chloride
IDCSB-5-A	0-2	6U	**5.6J**	**260J**	**18**
IDCSB-5-B	4-8	**1200J**	**240J**	**1200J**	**39**
IDCSB-5-C	8-12	**1600**	**210J**	**750**	**100**
IDCSB-5-C	8-12 (Dup)	**1900**	**270J**	**960**	**60**
IDCSB-5-D	20-24	**2800**	**220J**	**770**	**21**
IDCSB-5-E	32-36	**1200**	**65**	**190**	8U
IDCSB-5-F	44-48	**570**	**7.1**	**8.3**	7U

IDCSB-7					
VOCs (µg/kg)					
Sample ID	Depth (ft bgs)	PCE	TCE	CIS-1,2 DCE	Vinyl Chloride
IDCSB-7-A	0-2	0.89J	2.3J	210J	**85**
IDCSB-7-B	4-8	6.5U	6.5U	**51**	**43**
IDCSB-7-C	8-12	**110**	**56**	**430J**	**120**
IDCSB-7-C	8-12 (Dup)	**83**	**38**	**270**	**64**
IDCSB-7-D	20-24	**290J**	**110**	**330J**	**42**
IDCSB-7-E	32-36	**200J**	**30**	**430J**	6.6U
IDCSB-7-F	44-48	**660J**	**27**	**240J**	6.1U

IDCSB-04			
VOCs (µg/kg)			
Event	Depth (ft bgs)	TCE	CIS-1,2 DCE
IDCSB-04-A	2-4	**2.5J**	**15**

IDCSB-6					
VOCs (µg/kg)					
Sample ID	Depth (ft bgs)	PCE	TCE	CIS-1,2 DCE	Vinyl Chloride
IDCSB-6-A	0-2	6.4U	15	**690**	**410**
IDCSB-6-B	4-8	**670**	**490**	**4700**	**1200**
IDCSB-6-C	8-12	**1400**	**450**	**4000**	**490J**
IDCSB-6-D	20-24	**2800**	**450**	**2900**	**210**
IDCSB-6-E	32-36	**2000**	**150**	**280**	**22**
IDCSB-6-F	44-48	**290**	**3.1J**	**2.9J**	7.7U
IDCSB-6-G	56-60	**170**	**0.99J**	7U	7U

IDCSB-12				
VOCs (µg/kg)				
Sample ID	Depth (ft bgs)	PCE	TCE	CIS-1,2 DCE
IDCSB-12-A	0-2	**10**	**0.98J**	6.7U
IDCSB-12-B	4-8	**2.6J**	**0.89J**	**65**

IDCSB-11				
VOCs (µg/kg)				
Sample ID	Depth (ft bgs)	PCE	TCE	CIS-1,2 DCE
IDCSB-11-A	0-2	470U	470U	**580**
IDCSB-11-B	4-8	1000U	1000U	**16000**
IDCSB-11-C	8-12	**1700**	**1800**	**11000**

IDCSB-01			
VOCs (µg/kg)			
Sample ID	Depth (ft bgs)	TCE	CIS-1,2 DCE
IDCSB-01-A	1-4	**2.3 J**	**3.9 J**

IDCSB-14				
VOCs (µg/kg)				
Sample ID	Depth (ft bgs)	PCE	TCE	CIS-1,2 DCE
IDCSB-14-A	0-2	**180J**	**920**	**4200**
IDCSB-14-B	4-8	**1700000**	**28000J**	**29000J**

IDCSB-13				
VOCs (µg/kg)				
Sample ID	Depth (ft bgs)	PCE	TCE	CIS-1,2 DCE
IDCSB-13-A	0-2	**64000**	**2100J**	**3700**
IDCSB-13-B	4-8	**45000**	**9000**	**23000**
IDCSB-13-C	8-12	**120000**	**7300J**	**14000**

IDCSB-10				
VOCs (µg/kg)				
Sample ID	Depth (ft bgs)	PCE	TCE	CIS-1,2 DCE
IDCSB-10-A	0-2	**40000**	**3000**	**900J**
IDCSB-10-B	4-8	**140000**	**13000**	**18000**
IDCSB-10-C	8-12	**170000**	**25000**	**21000**

IDCSB-03				
VOCs (µg/kg)				
Sample ID	Depth (ft bgs)	PCE	TCE	CIS-1,2 DCE
IDCSB-03-A	3-4	**16000**	**12000**	**14000**
IDCSB-03-B	4-6	**270000**	**39000**	**14000J**
IDCSB-03-B	4-6 (Dup)	**11000**	780U	780U

Remedial Investigation* Soil Screening Criteria for Site-Related Contaminants	
VOC	Standards (µg/kg)
PCE	46.0
TCE	36.0
cis-1,2 DCE	420.0
1,1 - DCE	50.0
Vinyl chloride	13.8
Values that exceed screening criteria are highlighted in yellow	
Values in bold represent detections	

Notes:
Detections are in bold
ft bgs - feet below ground surface
J - estimated value
µg/kg - micrograms per kilograms
U - not detected above the listed detection limit

VOC - volatile organic compound
PCE - tetrachloroethene
TCE - trichloroethene
DCE - dichloroethene
SRC - Site Related Contaminants

0 3.75 7.5 15 22.5 30 Feet

Figure 4
IDC Remediation Target Zone
Cidra Groundwater Contamination Site
Cidra, Puerto Rico

CDM Smith

R2-0009088

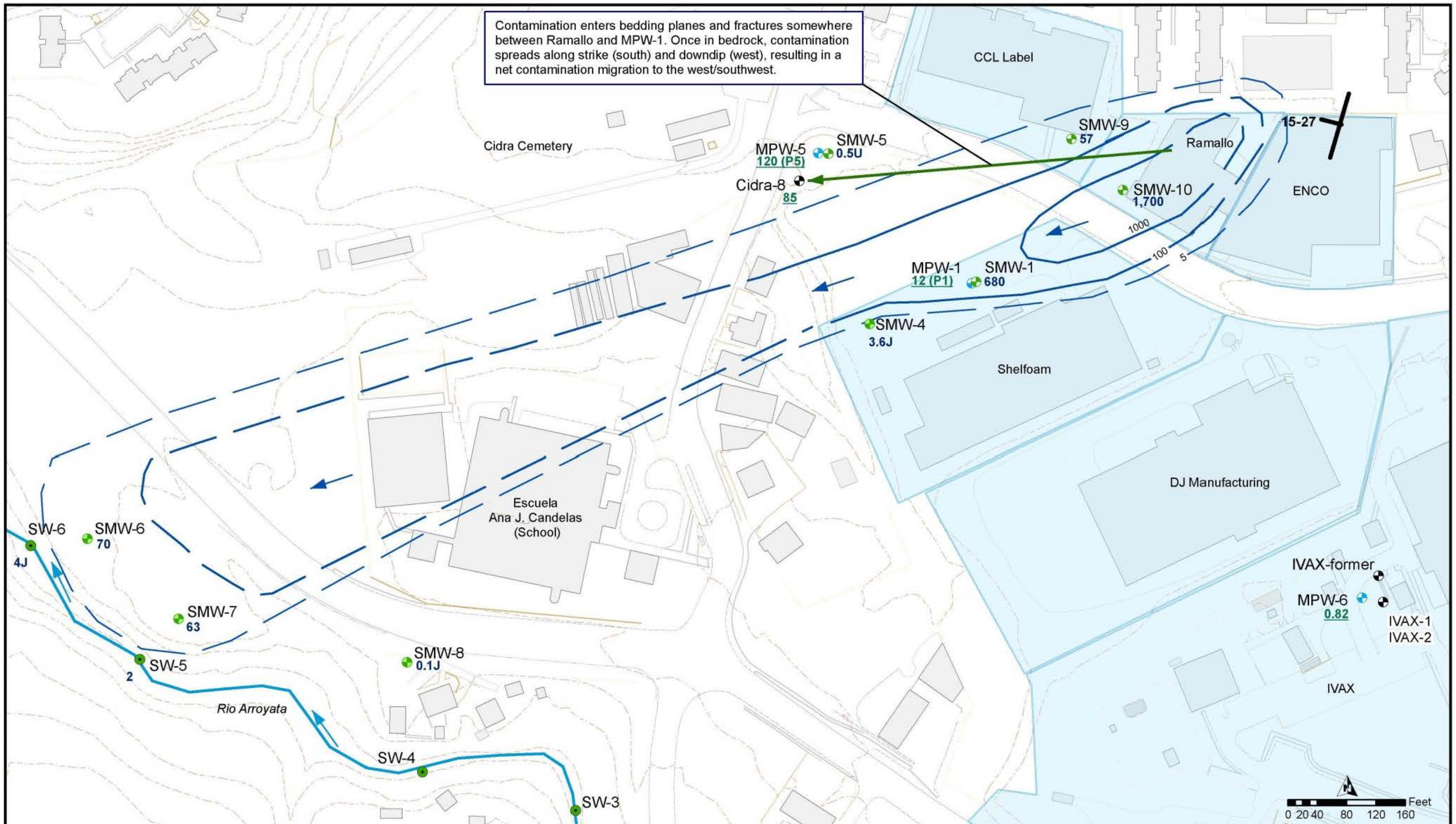
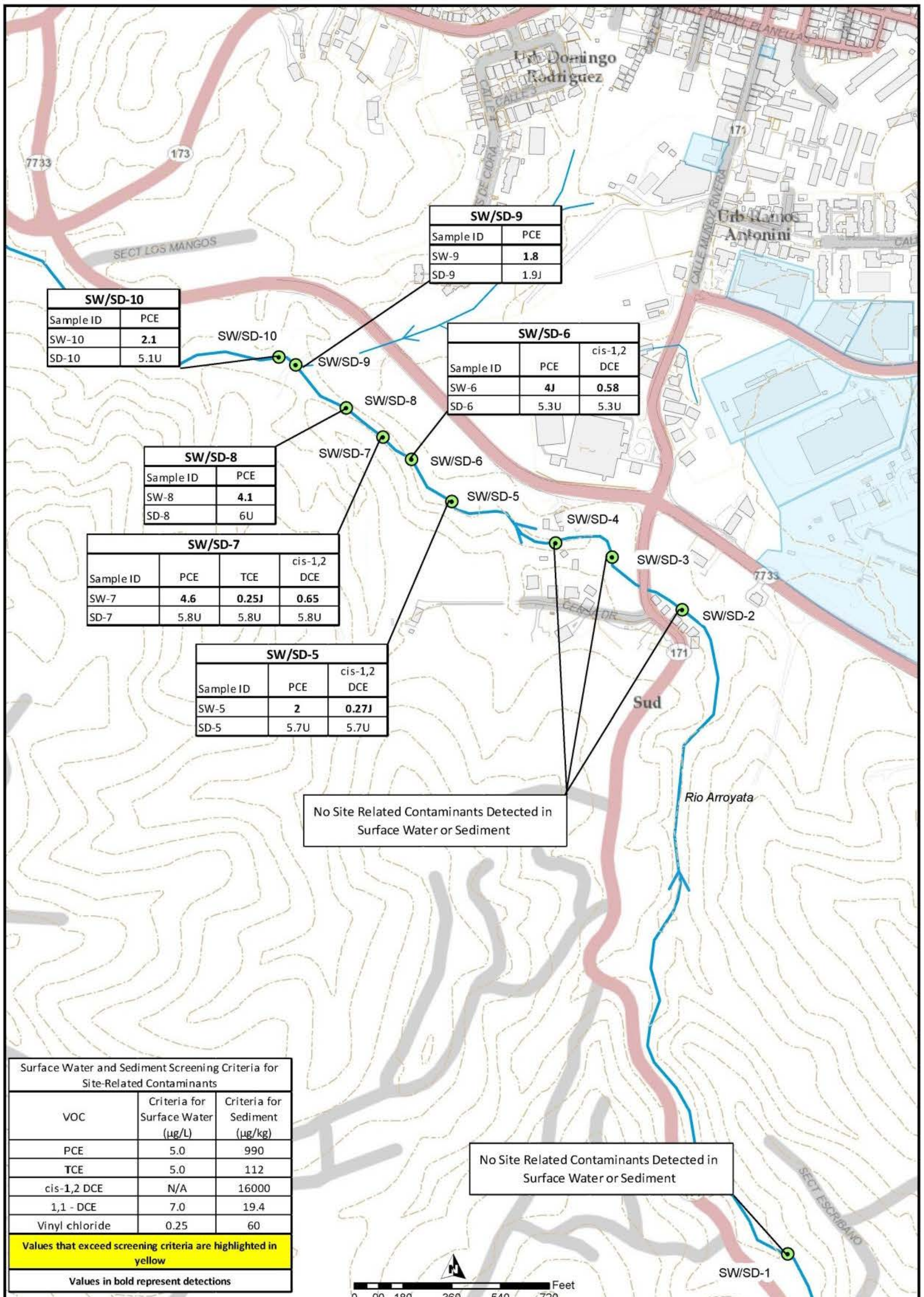


Figure 5
PCE Plume in Saprolite
Cidra Groundwater Contamination Site
Cidra, Puerto Rico

R2-0009089



Notes:
All sediment results in micrograms per liter (µg/L)
All surface water results in micrograms per kilogram (µg/kg)
U - not detected above the listed detection limit
VOC - volatile organic compound
PCE - tetrachloroethene
TCE - trichloroethene
DCE - dichloroethene
J- estimated value

Figure 6
Site-Related Contaminant Surface Water and Sediment Results
Cidra Groundwater Contamination Site
Cidra, Puerto Rico

CDM Smith